Exhibit 31

31 October 2019
Equity Research
Americas | United States

CREDIT SUISSE

Apache Corporation

3Q Beat, but Tempers 4Q Guidance & 2020 Capex; Raising Estimates on Cost Cuts/Shift to Oilier Plays

Oil & Gas Exploration & Production | Forecast Increase

APA

Target price (12M, US$)
20.00
Neutral[V]

Price (30 Oct 19, US$)	21.36
52-week price range	37.81 - 19.93
Market cap (US$ m)	8,030.48
Enterprise value (US$ m)	15,976

[V] = Stock Considered Volatile (see Disclosure Appendix)

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- **Shifting capital away from Alpine High helps but still not enough.** At current strip prices, APA expects its 2020 upstream spend to be ~10-20% lower YoY implying a budget of ~$2bn (~17% below consensus) to generate organic FCF generation that covers the current dividend and puts it on pace to fund a multi-year debt reduction program while also delivering "modest" YoY oil production growth. As a result of weak gas and NGL prices, APA will reallocate capital away from Alpine High to more oil-weighted international and Midland Basin assets. While we reduced our 2020+ capex forecasts and increased go-forward oil mix, we still estimate APA is roughly FCF neutral (after dividends) in 2020 and outspends by >$300MM per annum from 2021+. We raised 2020-22 CFPS by ~5% on the higher oil mix and lower costs (it is targeting $150MM of cost savings).
- **Maintains FY19 guidance but dials back 4Q volume outlook.** While APA maintained its FY19 capex budget of $2.4bn and "reported" production guidance of 465-476 MBoed, the latter is due to the large 3Q (gas) beat offsetting reduced 4Q guidance to 480-487 MBoed (from 481-496 MBoed). The 4Q reduction is entirely from the US where it now expects volumes of 286-290 MBoed (from 287-299 MBoed). Notably, due to weak gas and NGL pricing, APA has cut its Alpine High rig count from 5 to 2 rigs and deferring some 4Q completions into 2020; thus, APA now expects its 4Q volumes in the play to be ~94-96 MBoed (from >100 MBoed). It also reduced its 4Q Permian oil guidance to ~100 MBbld (from 100-105 MBbld) due to downtime/maintenance and completion delays.
- **3Q CFPS light but EBITDX beats.** Clean 3Q CFPS of $1.49 was 4% below CSe of $1.55 due to higher current taxes; however, EBITDX of $905MM was ~8-9% above expectations. Production of ~451 MBoed was above guidance of ~439 MBoed and ~2-4% above consensus/CSe driven entirely by higher gas/NGLs (oil volumes were in line). APA generated an organic ~$170MM FCF deficit in 3Q.
- **Fully valued vs. peers.** Our $20 TP is based on ~5x normalized 2020E DACF. Risks: Permian gas diffs, Alpine High and Suriname execution.

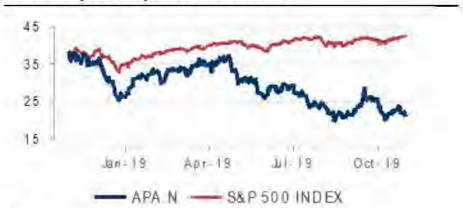
Financial and valuation metrics

Year	12/18A	12/19E	12/20E	12/21E
EBITDX (US$ m)	4,904.0	4,050.4	3,971.1	4,130.5
CFPS (US$)	8.10	7.10	7.50	7.85
Prev. CFPS (US$)	-	-	7.30	7.45
DACF	3,325.4	2,809.2	2,994.0	3,242.0
ROACE (%)	0.06	0.01	0.01	0.02
EV/EBITDX	3.2	3.9	3.9	3.8
EV/DACF	4.7	5.6	5.2	4.8
Net debt (US$ m)	7,568	7,946	7,904	7,778
EPS (CS Adj.) (US$)	1.77	0.05	-0.15	0.05

Dividend (current qtr., US$)	376.0	Dividend yield (%)	4.7
Net debt (current, US$)	7,945.7	Net debt/Cap (%)	0.47
NAV/share (12/19E, US$ m)	18.41	Net debt/EBITDX (x)	1.96
P/NAV (x)	1.2	Number of shares (m)	376.0
Free float (%)	89.8		

Source: Company data, Refinitiv, Credit Suisse estimates

Share price performance



On 30-Oct-2019 the S&P 500 INDEX closed at 3046.77Daily Oct31, 2018 - Oct30, 2019, 10/31/18 = US$37.83

Quarterly CFPS	Q1	Q2	Q3	Q4
2018A	1.76	2.07	2.27	2.00
2019E	1.76	1.62	1.49	2.22
2020E	1.95	1.90	1.83	1.83

Apache Corporation (APA)

Price (30 Oct 2019): **US$21.36** Target Price: **20.00**

Analyst: **William Featherston**
Rating: **Neutral [V]**

Income Statement	**12/18A**	**12/19E**	**12/20E**	**12/21E**
EBITDX (US$ m)	**4,904**	**4,050**	**3,971**	**4,131**
DACF	3,325	2,809	2,994	3,242
Net interest income (exp)	384	390	400	400
Net non operating inc (exp)	0	15	(15)	6
Share of associates/JVs' equity	-	-	-	-
Exceptionals	0	15	(15)	6
Profit before tax (US$ m)	**1,718**	**658**	**346**	**521**
Taxes	772	440	156	234
Profit after tax	946	218	190	287
Extraordinary gain/(loss)	0	0	0	0
Non-controlling interest (minority)	-	-	-	-
Preferred dividends	-	-	-	-
Adjusted net income (US$ m)	**946**	**218**	**190**	**287**
Cash Flow	**12/18A**	**12/19E**	**12/20E**	**12/21E**
Change in working capital	245	39	0	0
Other cash and non-cash items	1,430	1,864	2,106	2,110
Cash flow from operations	3,777	2,936	2,867	3,025
Capex	(3,771)	(4,129)	(2,332)	(2,211)
Acquisitions	(133)	(34)	(40)	(40)
Divestments	-	-	-	-
Other investment/(outflows)				
Cashflow from investment	(3,944)	(3,590)	(2,372)	(2,251)
Operating cash flow	**3,777.0**	**2,936.3**	**2,867.4**	**3,024.7**
Balance Sheet	**12/18A**	**12/19E**	**12/20E**	**12/21E**
Cash and cash equivalents	2,687	1,946	1,858	1,926
Other current assets	0	0	0	0
Total current assets	**2,687**	**1,946**	**1,858**	**1,926**
Total fixed assets	18,421	17,704	17,173	16,518
Other assets	474	1,779	1,779	1,779
Total assets	**21,582**	**21,428**	**20,810**	**20,223**
Total current liabilities	2,201	1,921	1,921	1,921
Long-term debt	8,054	8,478	8,518	8,460
Other Liabilities	**2,515**	**2,725**	**2,746**	**2,847**
Total liabilities	**12,770**	**13,124**	**13,185**	**13,228**
Shareholders' equity	7,130	6,198	5,518	4,889
Minority interest	1,682	2,106	2,106	2,106
Total equity and liabilities	21,582	21,428	20,810	20,223
Per share	**12/18A**	**12/19E**	**12/20E**	**12/21E**
Equiv. FPO (period Avg.) (mn)	383.25	376.50	377.00	380.00
CFPS (US$)	8.10	7.10	7.50	7.85
Prev. CFPS (US$)	-	-	7.30	7.45
DPS (US$)	1.00	1.00	1.00	1.00
Total Production	**12/18A**	**12/19E**	**12/20E**	**12/21E**
Total Production (MBoed)	465.9	473.2	480.7	482.4
Oil Production (MBbld)	245.4	239.5	239.7	240.2
NGL Production (MBbld)	59.6	74.7	91.5	91.9
Gas Production (MMcfd)	965.5	953.9	897.1	901.8
Valuation	**12/18A**	**12/19E**	**12/20E**	**12/21E**
Dividend yield (%)	4.7	4.7	4.7	4.7
FCF yield (%)	(16.5)	2.7	3.4	3.1
EV/EBITDX (x)	3.2	3.9	3.9	3.8
Returns	**12/18A**	**12/19E**	**12/20E**	**12/21E**
ROE (%)	0.09	0.00	(0.01)	0.00
ROACE (avg.) (%)	0.06	0.01	0.01	0.02
Gearing	**12/18A**	**12/19E**	**12/20E**	**12/21E**
Net debt/Cap (%)	85.9	95.7	103.7	111.2
Interest coverage ratio (X)	5.5	2.6	1.9	2.3

Source: Company data, Refinitiv, Credit Suisse estimates

Company Background

Apache is an oil and gas exploration and production company engaged in the acquisition, exploration, development, and production of oil and gas in the onshore US, Gulf of Mexico, Egypt, and North Sea.

Blue/Grey Sky Scenario

Our Blue Sky Scenario (US$) **31.00**

Our Blue Sky Scenario assumes a flat $10/Bbl and $0.25/MMBtu premium to the Credit Suisse long-term, normalized price deck. However, we note that at these oil and gas prices, APA would be generating additional free cash flow versus our base case. This extra cash would allow the company to accelerate drilling activity which could provide additional upside.

Our Grey Sky Scenario (US$) **9.00**

Our Grey Sky Scenario assumes a $10/Bbl and $0.25/MMBtu discount to the Credit Suisse long-term, normalized price deck. However, we note that at these oil and gas prices, APA would be generating less free cash flow which could mean lower drilling activity than our base case. Under this scenario, value would be deferred and further downside could be warranted.

Share price performance

On 30-Oct-2019 the S&P 500 INDEX closed at 3046.77
Daily Oct31, 2018 - Oct30, 2019, 10/31/18 = US$37.83

Investment Thesis

APA's shift to a slower-growth model and reallocation of capital away from the gas/NGL-levered Alpine High play leave it with a flattish near-term production profile but a higher go-forward oil mix and enable an improvement in 2020-21E FCF. However, we believe it will struggle to sustain a peer-competitive FCF yield beyond this year and will continue to outspend the dividend at current strip prices. Despite the improved FCF, we still have APA lagging peers on cash flow per debt-adjusted share growth over the next several years. Moreover, valuation looks full to us at current levels, with shares trading above peers on 2020-21E EV/DACF (vs. historical >1.0x discount) and a material premium to NAV.

Key Highlights from 3Q Results

- **At current strip prices, APA expects 2020 upstream capex to be ~10-20% lower than this year's budget of $2.4 billion.** While formal guidance will be provided in February, this implies an upstream budget next year closer to ~$2 billion, below our prior estimate of ~$2.2 billion and consensus of ~$2.4 billion (although some estimates may include Alpine High midstream spending). As a reminder, APA's preliminary 2020-21 outlook earlier this year pointed to moderately higher capex of $2.5-$2.8 billion, with focus on FCF neutrality at $50-55/Bbl WTI while enabling "at least" single-digit production growth but then noted on its 2Q conference call that 2020 capex would likely be "$2.4 billion or lower."
  - **But due to much weaker NGL prices (>50% Alpine High's production in 2020), APA will likely slash spending in the play next year (already dropped from 5 rigs to 2 rigs) party offset by an increase to Egypt, North Sea (e.g., Garten well), and/or the Midland Basin.** APA believes this plan will enable organic free cash flow generation that covers the current dividend and puts it on pace to fund a multiyear debt reduction program while also delivering "modest" YoY oil production growth. Interestingly, APA previously noted it planned to return at least 50% of any surplus cash flow generated (including potential asset sale proceeds) to shareholders before contemplating higher activity levels. However, management now seems to prefer potential organic FCF surplus for debt repayment.
  - **We lowered our 2020 upstream capex forecast to ~$2 billion and modestly reduced our 2020 volume to ~481 MBoed (from ~488 MBoed and below consensus of ~489 MBoed**) as we assume a reduction in Alpine High activity/volumes if offset by shifting more capital to its more oily-weighted international and Midland Basin assets…leaving APA roughly FCF neutral (after dividends) under current futures strip prices next year (vs. ~$175 million FCF *deficit* prior).
- **Slower growth and capital allocation shift to oilier plays improves 2020-21E FCF yield, but still outspending the dividend assuming the futures strip.** We lowered 2020-21 Upstream capex to ~$2.0-$2.1 billion per annum (down from ~$2.25-$2.55 billion prior), driven by reduced activity levels in Alpine High. With some of that spending reallocated to its other Permian assets and the North Sea, modest reductions to our 2020-21 total volume forecasts were partly offset by higher oil volumes (raised ~1-2%), improving APA's go-forward oil mix. Overall the revisions to our model boosted APA's 2020 organic FCF surplus (Upstream) by ~$200 million (to a ~5% FCF yield, now competitive with large-cap peers) and flipped 2021E from a ~$350 million FCF deficit to a ~$125 million surplus (still a below-average 2021 FCF yield of ~1.5% vs. peers' ~4-5%). Beyond 2021, we now have APA near FCF neutrality (pre-dividend) at current strip prices, a stark improvement vs. our prior forecasts but nonetheless underscoring the broader difficulty of reaching and sustaining a competitive FCF yield over the long-term. This also leaves APA outspending cash flow after funding the ~$380 million annual dividend payment. Revisions were slightly

dilutive (~0.2x) to 2019-20E EV/DACF valuation, but roughly a half turn accretive to 2021+.

Figure 1: Revised CS 2019-23 Production, Capex, FCF and Valuation vs. Prior Forecasts (Current Strip Prices)

	Prior CS Forecasts (Current Strip Prices)					Revised CS Forecasts (Current Strip Prices)				
	2019	2020	2021	2022	2023	2019	2020	2021	2022	2023
WTI Oil ($/Bbl)	$56.43	$53 69	$51.95	$51.27	$51 34	$56.43	$53.69	$51.95	$51.27	$51 34
NYMEX Gas ($/MMBtu)	$2.66	$2.50	$2.47	$2.50	$2 57	$2.66	$2 50	$2.47	$2.50	$2 57
Total "Reported" Production (MBoed)	**471**	**488**	**507**	**553**	**595**	**473**	**481**	**482**	**510**	**524**
% YoY	*1%*	*4%*	*4%*	*9%*	*8%*	*2%*	*2%*	*0%*	*6%*	*3%*
Oil Production (MBbld)	**241**	**238**	**235**	**242**	**246**	**240**	**240**	**240**	**251**	**256**
% YoY	*-2%*	*-1%*	*-1%*	*3%*	*2%*	*-2%*	*0%*	*0%*	*4%*	*2%*
($MM)										
Total Upstream Capex	($2,577)	($2,243)	($2,548)	($2,710)	($2,735)	($2,606)	($2,017)	($2,075)	($2,234)	($2,260)
Upstream Discretionary Cash Flow	$2,536	$2,449	$2,201	$2,213	$2,313	$2,534	$2,422	$2,199	$2,217	$2,291
Organic FCF Surplus/(Deficit)	**($41)**	**$206**	**($347)**	**($497)**	**($421)**	**($72)**	**$405**	**$125**	**($17)**	**$31**
Organic FCF Yield (Before Dividends)	*-0.5%*	*2.5%*	*-4.3%*	*-6.1%*	*-5.1%*	[illegible]	*5.0%*	*1.5%*	*-0.2%*	*0.4%*
Net Debt/EBITDX (YE)	2.0x	2.4x	2.8x	3.1x	3 3x	2.0x	2.3x	2.4x	2.5x	2 5x
EV/DACF	**5.9x**	**5.8x**	**6.3x**	**6.5x**	**6.6x**	**6.1x**	**6.0x**	**6.0x**	**6.0x**	**6.0x**

Source: Company data, Credit Suisse estimates, the BLOOMBERG PROFESSIONAL™ service

Note: Based on current NYMEX Brent, WTI, and Henry Hub futures strip prices: 2019 - $63.81/Bbl, $56.45/Bbl, & $2.77/MMBtu; 2020 - $58.61/Bbl, $53.69/Bbl, & $2.5/MMBtu; 2021 - $57.28/Bbl, $51.95/Bbl, & $2.47/MMBtu; 2022 - $56.85/Bbl, $51.27/Bbl, & $2.5/MMBtu; and 2023+ - $57.16/Bbl, $51.34/Bbl, & $2.57/MMBtu.

- **Upstream spending remains on track to meet its FY19 budget of $2.4 billion (down ~22% YoY).** Through 3Q19, APA's upstream spend was ~$1.78 billion, leaving on track to meet its full year budget particularly as the company has reduced drilling activity in the Alpine High (more detail below). Roughly ~72% (vs. ~75% prior) of this year's upstream budget is allocated to its US onshore programs, namely the Permian Basin where its current run-rate implies an average of 10igs (down from ~12 in 2Q19) between Alpine High (we now assume ~80 wells to be brought online) and its remaining Delaware/Midland developments (~128 wells online). The remaining ~28% (vs. ~25% prior) of the budget will be directed to its International assets, including Egypt (~7-8 rig program, drilling 40 development and 30 exploration wells), the North Sea (11 wells planned for Beryl area, with another six at Forties) as well as its first exploration well offshore Suriname, where it holds a 100% working interest in Block 58 (adjacent to the Stabroek block offshore Guyana where XOM/HES and partners have made 14 discoveries and found >6.0 BBoe to date). *At current strip prices, we forecast APA's upstream business will generate a ~$450 million of organic FCF deficit (after dividends) this year albeit roughly breakeven in 4Q19).*

- **Maintains 2019 "reported" production guidance of 465-476 MBoed (+3-5% YoY pro-forma for asset sales) as the 3Q production beat was offset by lowered 4Q guidance.** For FY19, US volume guidance remains 270-280 MBoed which is up +9-13% YoY pro-forma for the Mid-Con asset sales which closed in May and July. The company also maintained its 2019 "reported" international production guidance of 195-196 MBoed (down ~4% YoY). However, APA is able to maintain its FY19 guidance as 3Q US volumes came in ~11 MBoed above the mid-point of its guidance (albeit entirely driven by gas) while international production beat by ~1 MBoed. *We raised our 2019 production forecast entirely on the 3Q beat from ~471 MBoed to ~473 MBoed, in line with APA's guidance range.*
  - This year's growth will continue to be driven by APA's **Alpine High** assets where it continues to expect volumes to average 72-75 MBoed (up 75% YoY). However,

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given continued weakness in gas and NGL pricing, APA has reduced Alpine High activity to two rigs (from five rigs prior) and chosen to defer some 4Q completions into 2020 which, combined with lower than expected volumes from its recent Blackfoot pad, is causing a reduction to its 4Q19 production rate in the play to ~94-96 MBoed (from >100 MBoed prior). We'd note that the Alpine High volumes previously deferred due to low Waha prices were returned to production during August and September. We also expect volume growth to come from its remaining **Midland/Delaware Basin** (ex-Alpine High) assets (CSe +6% YoY), although APA now expects its 4Q **Permian oil** production to be ~100 MBbld (vs. 100-105 MBbld prior) due to a combination of unplanned downtime, delay in completions, and well maintenance timing.

– As such, APA reduced its **4Q US volume guidance** from 287-299 MBoed to 286-290 MBoed and maintained its **4Q international production guidance** (including Egypt tax barrels and noncontrolling interest) of 194-197 MBoed. Overall, APA's companywide **4Q "reported" volume guidance** of 480-487 MBoed came in below our comparable forecast of ~491 MBoed (compares to consensus of ~476 MBoed although some estimates may exclude Egypt tax barrels and noncontrolling interest). *We lowered our 4Q companywide production forecast to ~485 MBoed (vs. ~491 MBoed prior).*

■ **We expect APA to generate below-average cash flow and production per debt-adjusted share growth over the next several years assuming current futures strip prices.** We prefer to measure E&P companies' growth on a debt-adjusted per share basis given disparate capital allocation decisions between growth capex, debt level changes, share repurchases, etc. We'd note cash flow per debt-adjusted share growth has consistently been the metric with the highest correlation to intra-sector relative performance. From 2018-23 and assuming current futures strip prices, we forecast APA's cash flow and production per debt-adjusted share will *decline* ~10% and ~5% per annum, respectively, well below global large-cap E&Ps which we expect to *grow* ~2% and ~6% per annum over the same time period.

Figure 2: APA's Production and Cash Flow Per Debt-Adjusted Share Growth Outlook vs. Peers

	Debt-Adjusted Growth Metrics (CS Price Deck)								Debt-Adjusted Growth Metrics (Strip Prices)							
	YoY DAPPS Growth				YoY DACFPS Growth				YoY DAPPS Growth				YoY DACFS Growth			
	2019	2020	2021	'18-23 CAGR	2019	2020	2021	'18-23 CAGR	2019	2020	2021	'18-23 CAGR	2019	2020	2021	'18-23 CAGR
COP	12%	5%	9%	9%	6%	-2%	12%	6%	12%	4%	7%	7%	3%	-7%	3%	1%
HES	3%	10%	2%	5%	-5%	8%	9%	8%	3%	10%	1%	5%	-6%	3%	2%	4%
MRO	-10%	5%	9%	6%	-16%	1%	13%	4%	-10%	4%	8%	4%	-19%	-1%	5%	0%
MUR	-7%	23%	6%	10%	-9%	20%	3%	9%	-8%	22%	5%	8%	-13%	19%	-3%	5%
NBL	-2%	14%	11%	9%	-23%	35%	22%	12%	-2%	14%	10%	8%	-24%	34%	16%	10%
OXY	-4%	5%	2%	3%	-34%	-8%	4%	-7%	-4%	4%	1%	2%	-36%	-9%	-3%	-9%
Peer Average	**-1%**	**10%**	**7%**	**7%**	**-13%**	**9%**	**10%**	**5%**	**-1%**	**10%**	**6%**	**6%**	**-16%**	**7%**	**3%**	**2%**
APA	**-23%**	**1%**	**0%**	**-3%**	**-35%**	**5%**	**6%**	**-5%**	**-23%**	**0%**	**-2%**	**-5%**	**-38%**	**-3%**	**-6%**	**-10%**

Source: Company data, Credit Suisse estimates

■ **Suriname well should reach TD in November; we see considerable downside risk to shares if the prospect is dry.** In late September, APA spud its highly-anticipated **Maka Central #1** exploration well on Suriname Block 58, which is expected to reach total depth in November. The well is located just seven miles from the Suriname/Guyana maritime border and adjacent to the XOM-operated Stabroek Block offshore Guyana where 14 major discoveries (with >6 BBoe of oil-weighted resource) have been identified to date. Expectations for the well are exceedingly high, underscored by the sharp selloff in the stock last Friday after news broke that APA's head of Worldwide Exploration had departed the company – supposedly unrelated to Suriname, though with APA in the middle of drilling the well the timing nonetheless spooked investors. *Given its wide relative valuation premium, we estimate APA shares are already pricing in a ~750 MMBoe discovery in Suriname and could*

see meaningful downside risk in the event the well is unsuccessful: we'd note our 2P NAV (which excludes any Suriname value) at current strip prices is ~$12/share. Getting to a 2020 EV/DACF multiple more in line with peers implies a stock price in the mid-to-high teens.

Valuation

- **On EV/DACF, APA is trading at a 0.5-1 turn premium to peers in 2019-21.** Assuming current futures strip prices, we estimate APA is trading at 2020E EV/DACF multiples of ~6.0x, above the global large-cap E&P average (ex HES) of 5.2-5.4x. However, with ~65% of its cash flow derived from short reserve life North Sea and Egyptian assets generally valued at ~3.5x, the market is implicitly valuing APA's US onshore assets at ~10x 2020E DACF, ~5x turns above the pure-play Permian E&Ps that generally have higher oil growth and less execution risk than APA.
- **Meanwhile, APA is trading well above peers on P/NAV.** We estimate APA is trading at a material *premium* to 2P NAV under current futures strip prices, compared to peer average of a ~20% *discount*. We attribute much of this premium to the market baking in >750 MMBoe of resource on Block 58 in Suriname to which we do not ascribe value yet (we only ascribe value to exploration prospects after commercial success has been established).

Figure 3: APA's Valuation vs. Peers Under the Credit Suisse Price Deck and Current Futures Strip Prices

		Valuation (CS Price Deck)								Valuation (Strip Prices)				
	Share	EV/DACF				P/NAV		Reserve	Unbooked	EV/DACF			P/NAV	
Ticker	Price	Hist. FY1	2019	2020	2021	1P	2P	Life	to Proved	2019	2020	2021	1P	2P
COP	$55.04	6.4x	5.4x	5.6x	5.0x	NA	NA	11.2x	1.9x	5.6x	6.0x	5.9x	NA	NA
HES	$64.76	6.8x	9.9x	9.2x	8.6x	1.86x	0.96x	11.8x	2.3x	10.0x	9.7x	9.6x	2.07x	1.13x
MRO	$11.56	5.8x	4.0x	4.2x	3.8x	1.48x	0.58x	8.4x	2.8x	4.1x	4.4x	4.2x	1.81x	0.69x
MUR	$19.51	4.3x	3.9x	3.2x	3.2x	0.89x	0.52x	11.0x	4.0x	4.0x	3.4x	3.5x	1.08x	0.63x
NBL	$19.41	7.2x	7.3x	5.7x	4.7x	1.00x	0.63x	15.0x	2.2x	7.4x	5.9x	5.1x	1.10x	0.72x
OXY	$41.36	8.5x	5.8x	5.4x	5.3x	1.08x	0.66x	9.1x	2.0x	6.0x	7.3x	7.5x	1.23x	0.76x
Peer Average		**6.5x**	**6.0x**	**5.6x**	**5.1x**	**1.26x**	**0.67x**	**11.1x**	**2.2x**	**6.2x**	**6.1x**	**6.0x**	**1.46x**	**0.78x**
Peer Average (ex HES)		**6.4x**	**5.3x**	**4.8x**	**4.4x**	**1.11x**	**0.60x**	**10.9x**	**2.6x**	**5.4x**	**5.4x**	**5.2x**	**1.30x**	**0.70x**
APA	**$21.36**	**5.5x**	**5.7x**	**5.5x**	**5.1x**	**2.28x**	**1.16x**	**7.3x**	**7.5x**	**6.1x**	**6.0x**	**6.0x**	**2.91x**	**1.57x**

Source: Company data, Credit Suisse estimates

Operational Highlights

- Net production from **Alpine High** recovered to ~76 MBoed in 3Q (just above the 70-75 MBoed guidance range, though this had been revised downward) as volumes that were previously deferred due to weak Waha pricing were brought back on during August/September. APA ran an average of five rigs in the play in 3Q (placing 15 new wells on production), but has since dropped to just two rigs and has opted to defer some 4Q completion activity into 2020 given continued pressure on natural gas/NGL pricing. Combined with weaker than expected performance from a recent multi-well pad (Blackfoot), the reduced activity levels prompted APA to lower its 4Q Alpine High volume guidance from >100 MBoed to ~94-96 MBoed. Consistent with prior expectations, 4Q guidance assumes no underlying volume deferrals, as APA has returned shut-in production to sales in conjunction with startup of the Gulf Coast Express Pipeline (APA has ~500 MMcfd of takeaway capacity). At last update, APA had 880 MMcfd of processing capacity installed at YE18. It also expects 3 cryogenic facilities with 200 MMcfd each to be online next year, implying a total of ~1.4 Bcfd of takeaway capacity. APA holds a total of ~300,000 net acres in the Alpine High (primarily in the wet gas play), which we estimate adds >4,000 net

unbooked drilling locations and >7 BBoe of net resource potential worth <$1/share to APA's NAV.

- Aggregate volumes from its remaining **Permian** assets rose ~0.5% QoQ and ~3% YoY to ~178 MBoed, ~3% above our forecast. In the **Delaware Basin** (excluding Alpine High), APA operated an average two rig program in 3Q and brought nine wells to sales. It ran another three rigs in the **Midland Basin,** placing 20 new wells on production during the quarter. The company pointed to unplanned downtime and recent completion timing delays which have negatively impacted 2H19 production relative to expectations: as a result, it reduced 4Q Permian oil volume guidance (which does include Alpine High) to ~100 MBbld, the low-end of its prior 100-105 MBbld range.

- In **Egypt,** 3Q production averaged ~131 MBoed, flattish QoQ but above our ~124 MBoed forecast. Excluding minority interest and the impact of tax barrels, "adjusted" 3Q production was ~72 MBoed. APA continued to run a 7 rig program during the quarter and it drilled/completed 14 gross operated wells, including its second well brought online in the **Cobra** field on the **East Bahariya** concession. The company plans to average 7-8 rigs in Egypt this year and drill 40/30 development/exploration wells focusing on new acreage and areas with new 3-D seismic (has already identified "several hundred" new leads and prospects thus far).

- **North Sea** volumes fell ~10% QoQ to ~54 MBoed (partly due to anticipated seasonal platform maintenance), roughly in line with our forecast. Development of the **Storr** discovery remains on schedule (first well expected to come online in November), while the second **Garten** well (massive 1,200 feet of oil pay) should be online in late 4Q19. Earlier this year, APA completed a farm-out agreement with Chrysaor in a portion of the Beryl area to enable the continuation of tertiary exploration while preserving capital. At last update, APA expected to operate two platform rigs and one floating rig to drill 11 wells in the Beryl area and six wells at Forties this year. We expect the prolific Garten well to be a material contributor to APA's ability to deliver modest oil growth in 2020.

Figure 4: Summary of APA's Unbooked Resource Inventory and 2P NAV

Apache (APA)

Net Asset Value Summary

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Shares Out. (MM) **379.0**

Proved Reserves	**Liquids**	**Gas**	**Total**			**NPV-10**	
Oil & Gas Properties	(MMBbls)	(Bcf)	(MMBoe)	**% Liq**	($/Boe)	($MM)	($/Share)
United States	577	1,893	893	65%	$6.20	$5,536	$14.60
Egypt	80	339	137	59%	$13.79	$1,885	$5.00
North Sea	118	111	137	86%	$11.01	$1,507	$4.00
Total Proved Properties	**775**	**2,344**	**1,166**	**34%**	**$7.66**	**$8,927**	**$23.60**

Other Assets	($MM)	($/Share)
Other Assets	$2,193	$5.80

Liabilities & Working Capital	($MM)	($/Share)
Long-Term Debt & Preferred Stck	($8,054)	($21.25)
Working Capital	$486	$1.28
Total	**($7,568)**	**($20.00)**

Proved Net Asset Value (1P NAV, ex-undeveloped acreage)	**$3,552**	**$9.37**

Unbooked Reserves	**Liquids**	**Gas**	**Total**			**NPV-10**	
Oil & Gas Properties	(MMBbls)	(Bcf)	(MMBoe)	**% Liq**	($/Boe)	($MM)	($/Share)
Alpine High (Wet Gas Play)	3,074	12,215	5,110	60%	$0.00	$0	$0.00
Alpine High (Dry Gas Play)	0	13,053	2,176	0%	$0.00	$0	$0.00
Alpine High (Oil Play)	164	286	212	78%	$1.28	$272	$0.70
Delaware Basin Other Areas	84	146	108	78%	$0.72	$78	$0.20
Midland Basin Core Area	1,194	1,497	1,444	83%	$1.96	$2,833	$7.50
Central Basin Platform (Horizontal)	76	79	89	85%	$0.00	$0	$0.00
Eagle Ford (Area A)	190	391	255	74%	$0.00	$0	$0.00
Eagle Ford (Area B)	137	177	167	82%	$0.00	$0	$0.00
Total	**4,920**	**27,844**	**9,560**	**49%**	**$0.33**	**$3,183**	**$8.40**
International Assets							
Egypt (Unbooked)	221	936	377	59%	$0.65	$244	$0.60
Total Unbooked Resources	**5,140**	**28,780**	**9,937**	**48%**	**$0.34**	**$3,427**	**$9.04**
Total Net Asset Value	**5,916**	**31,124**	**11,103**	**47%**	**$0.63**	**$6,979**	**$18.41**

Source: Company data and Credit Suisse estimates

Figure 5: APA's Third Quarter Results vs. Prior CSe and Consensus

	Third Quarter Results			Results vs. Estimates			Bbg Consensus	
	3Q19	3Q18	% Change	3Q19A	3Q19E	% Change		
Production Volumes:								
Oil Production (MBbld)	228.4	243.4	-6%	228.4	227.5	0%	227.3	0%
NGL Production (MBbld)	74.4	62.0	20%	74.4	73.8	1%	64.3	16%
Gas Production (MMcfd)	886.6	1,024.9	-13%	886.6	804.0	10%	895.5	-1%
Total Production (MBoed)	**450.6**	**476.3**	**-5%**	**450.6**	**435.3**	**4%**	**441.5**	**2%**
Total Production (MMBoe)	**41.5**	**43.8**	**-5%**	**41.5**	**40.0**	**4%**		
Prices:								
Crude Oil ($/Bbl)	$58.69	$69.14	-15%	$58.69	$58.59	0%	$56.30	
Natural Gas Liquids ($/Bbl)	13.73	31.42	-56%	13.73	13.69	0%	13.80	
Natural Gas ($/Mcf)	1.66	2.56	-35%	1.66	1.68	-1%	1.74	
Total ($/Boe)	**$35.28**	**$44.94**	**-21%**	**$35.28**	**$36.06**	**-2%**	**$34.53**	
E&P Unit Costs ($/Boe):								
Depreciation, depletion, and amortization	$17.15	$13.92	23%	$17.15	$14.75	16%		
Lease operating costs	8.44	8.72	-3%	8.44	9.00	-6%		
Gathering and transportation	1.59	2.10	-24%	1.59	2.00	-20%		
Production taxes	1.06	1.32	-20%	1.06	1.11	-4%		
General and administrative	2.36	2.01	18%	2.36	2.70	-12%		
Exploration Expense	1.06	1.37	-22%	1.06	1.30	-18%		
Interest Expense	2.29	2.24	2%	2.29	2.45	-6%		
Total	**$33.96**	**$31.68**	**7%**	**$33.96**	**$33.31**	**2%**		
Pre-Tax Income Per Boe	**$1.32**	**$13.27**	**-90%**	**$1.32**	**$2.75**	**-52%**		
Cash Flow Per Boe	**$13.55**	**$19.91**	**-32%**	**$13.55**	**$14.58**	**-7%**		
Earnings Per Share	**($0.29)**	**$0.63**	**-145%**	**($0.29)**	**($0.03)**	**872%**	**($0.20)**	**45%**
Cash Flow Per Share	**$1.49**	**$2.27**	**-34%**	**$1.49**	**$1.55**	**-4%**	**$1.50**	**-1%**
DACF ($MM)	**$570**	**$938**	**-39%**	**$570**	**$632**	**-10%**		
EBITDX ($MM)	**$905**	**$1,378**	**-34%**	**$905**	**$835**	**8%**	**$830**	9%

Source: Company data, Credit Suisse estimates, the BLOOMBERG PROFESSIONAL™ service

Companies Mentioned *(Price as of 30-Oct-2019)*
Apache Corporation (APA.N, $21 36, NEUTRAL[V], TP $20.0)
ConocoPhillips (COP.N, $55.04)
Hess Corporation (HES.N, $64.76)
Marathon Oil Corporation (MRO.N, $11.56)
Murphy Oil Corporation (MUR.N, $19.51)
Noble Energy, Inc. (NBL.N, $19.41)
Occidental Petroleum Corporation (OXY.N, $41.36)

Disclosure Appendix

Analyst Certification

I, William Featherston, certify that (1) the views expressed in this report accurately reflect my personal views about all of the subject companies and securities and (2) no part of my compensation was, is or will be directly or indirectly related to the specific recommendations or views expressed in this report.

3-Year Price and Rating History for Apache Corporation (APA.N)

APA.N Date	Closing Price (US$)	Target Price (US$)	Rating
03-Nov-16	55.52	72.00	N
15-Nov-16	63.39	77.00	
30-Mar-17	52.09	73.00	
06-Apr-17	52.96	70.00	
10-Jul-17	47.11		NC
11-Dec-17	40.19	40.00	N *
22-Jan-18	47.66	43.00	
22-Feb-18	34.85	39.00	
12-Apr-18	39.38	40.00	
10-Jul-18	48.61	46.00	
19-Dec-18	28.75	36.00	
28-Feb-19	33.18	37.00	
02-May-19	29.78	33.00	
09-Jul-19	26.95	25.00	
03-Oct-19	23.37	20.00	

** Asterisk signifies initiation or assumption of coverage.*

Effective July 3, 2016, NC denotes termination of coverage.

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Outperform (O) : The stock's total return is expected to outperform the relevant benchmark* over the next 12 months.
Neutral (N) : The stock's total return is expected to be in line with the relevant benchmark* over the next 12 months.
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**Relevant benchmark by region: As of 10th December 2012, Japanese ratings are based on a stock's total return relative to the analyst's coverage universe which consists of all companies covered by the analyst within the relevant sector, with Outperforms representing the most attractive, Neutrals the less attractive, and Underperforms the least attractive investment opportunities. As of 2nd October 2012, U.S. and Canadian as well as European ratings are based on a stock's total return relative to the analyst's coverage universe which consists of all companies covered by the analyst within the relevant sector, with Outperforms representing the most attractive, Neutrals the less attractive, and Underperforms the least attractive investment opportunities. For Latin American and Asia stocks (excluding Japan and Australia), ratings are based on a stock's total return relative to the average total return of the relevant country or regional benchmark (India - S&P BSE Sensex Index); prior to 2nd October 2012 U.S. and Canadian ratings were based on (1) a stock's absolute total return potential to its current share price and (2) the relative attractiveness of a stock's total return potential within an analyst's coverage universe. For Australian and New Zealand stocks, the expected total return (ETR) calculation includes 12-month rolling dividend yield. An Outperform rating is assigned where an ETR is greater than or equal to 7.5%; Underperform where an ETR less than or equal to 5%. A Neutral may be assigned where the ETR is between -5% and 15%. The overlapping rating range allows analysts to assign a rating that puts ETR in the context of associated risks. Prior to 18 May 2015, ETR ranges for Outperform and Underperform ratings did not overlap with Neutral thresholds between 15% and 7.5%, which was in operation from 7 July 2011.*

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Underperform/Sell*	13%	(23% banking clients)
Restricted	2%	

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Target Price and Rating
Valuation Methodology and Risks: (12 months) for Apache Corporation (APA.N)

Method: Our 12-month target price of $20 per share for Apache Corp. assumes the stock trades to ~5x normalized 2020E DACF, in line with its historical average. Our Neutral rating is a function of total shareholder return over the next twelve months and the relative risk/reward versus our coverage universe.

Risk: We see several risks to APA achieving our $20 TP and our Neutral rating. APA has >10% of its production coming from Egypt, where political, social and economic conditions in the country could significantly worsen, and may lead to a reduction in the company's production, profits and stock price. In general, oil and gas companies are subject to changes in global commodity supply/demand, as well as geopolitical related issues that could adversely affect the company's ability to achieve our TP and could potentially lower our Rating.

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This research report is authored by:
Credit Suisse Securities (USA) LLC. William Featherston ; William Janela, CFA ; Michael Ziffer, CFA ; Christopher Zhang, CFA

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Exhibit 32

DOW JONES

THE WALL STREET JOURNAL.

CLM Business

SE Business

HD **Apache Shares Plunge Following Scant Update on South American Oil Prospect; Investors were awaiting results on Suriname well; company didn't say whether it struck oil**

BY By Rebecca Elliott

WC 565 words

PD 2 December 2019

ET 16:26

SN The Wall Street Journal Online

SC WSJO

LA English

CY

LP

Apache Corp. released a sparse progress report on its project to drill for oil off the coast of Suriname that raised more questions than answers and sent its stock price plunging.

Shares closed down 12.3% at $19.54, after falling by as much as 15% during trading Monday.

TD

Shareholders had been expecting the Houston-based company to shed light on the outcome of an exploratory offshore well near the small South American country. But instead of disclosing whether it had struck oil, Apache said that it is conducting additional tests and plans to drill deeper into the rock.

Many investors have been closely monitoring Apache's activity in the region, which is near a massive offshore oil field in Guyana that Exxon Mobil Corp. is developing. The lack of information Monday sent the company's shares plummeting on a day in which crude prices were up more than 1%.

"Additional information will be provided when the company is prepared to characterize the results," Apache said.

Apache's lackluster performance recently has ramped up pressure on the company's results in Suriname. As of Friday, before the company's Suriname announcement, the value of the Apache's shares including reinvested dividends had fallen roughly 35% in the last 12 months, FactSet data show, as Apache slowed production in the Permian Basin of West Texas and New Mexico due to low natural-gas and natural-gas-liquids prices. A broad index of U.S. oil and gas producers shed about 38% of its value in that time.

The company's prospects in the Permian region appeared bright in 2016 when it said it had discovered a new field it dubbed Alpine High. But Apache's assets in the Permian contain less oil and more natural gas than those of many of its peers. Natural gas is less valuable than oil, and the price of the commodity is expected to remain low due to a domestic glut of the fuel.

Analysts from energy investment bank Tudor, Pickering, Holt & Co. described the company's exploratory Suriname project as "among the most anticipated wells in the world."

"While we appreciate the desire to test multiple play concepts given promotion of the vast potential of this block, releasing the first update without any color on the results of the first two tests will not be taken well

by the market, and we expect most of the Suriname premium to erode," the analysts wrote in a note to investors.

In late October, Apache shares fell 5% in a day after it was reported that the company's senior vice president of world-wide exploration, Steve Keenan, had resigned, prompting concern about Suriname.

Chief Executive John Christmann that month told investors during Apache's third-quarter earnings call that Mr. Keenan's departure wasn't related to the Suriname project, attributing it instead to succession planning at the company.

"Steve did not have anything to do with us getting into Suriname or taking this block," Mr. Christmann said.

Apache reported a loss of $170 million in the third quarter, down from $81 million in profit during the same period a year earlier.

Write to Rebecca Elliott at rebecca.elliott@wsj.com

CO apche : Apache Corp

IN i1 : Energy | i13 : Crude Oil/Natural Gas Upstream Operations | i5020022 : Oil Production Platform Construction | iextra : Natural Gas/Oil Extraction | i1300003 : Crude Petroleum Extraction | i502 : Heavy Construction | iconst : Construction | icre : Real Estate/Construction

NS c15 : Financial Performance | c1522 : Share Price Movement/Disruptions | ccat : Corporate/Industrial News | m11 : Equity Markets | ncolu : Columns | nrmf : Routine Market/Financial News | mcat : Commodity/Financial Market News | ncat : Content Types | nfact : Factiva Filters | nfce : C&E Exclusion Filter | nfcpin : C&E Industry News Filter | niwe : IWE Filter

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Exhibit 33

UNITED STATES
SECURITIES AND EXCHANGE COMMISSION

Washington, D.C. 20549

FORM 8-K

CURRENT REPORT
Pursuant to Section 13 or 15(d)
of The Securities Exchange Act of 1934

Date of Report (Date of earliest event reported): February 26, 2020

APACHE CORPORATION

(Exact name of registrant as specified in its charter)

Delaware	1-4300	41-0747868
(State or other jurisdiction of incorporation)	(Commission File Number)	(IRS Employer Identification No.)

2000 Post Oak Boulevard
Suite 100
Houston, Texas 77056-4400
(Address of principal executive offices) (Zip Code)

Registrant's telephone number, including area code: (713) 296-6000

Check the appropriate box below if the Form 8-K filing is intended to simultaneously satisfy the filing obligation of the registrant under any of the following provisions:

☐ Written communications pursuant to Rule 425 under the Securities Act (17 CFR 230.425)

☐ Soliciting material pursuant to Rule 14a-12 under the Exchange Act (17 CFR 240.14a-12)

☐ Pre-commencement communications pursuant to Rule 14d-2(b) under the Exchange Act (17 CFR 240.14d-2(b))

☐ Pre-commencement communications pursuant to Rule 13e-4(c) under the Exchange Act (17 CFR 240.13e-4(c))

Securities registered pursuant to Section 12(b) of the Act:

Title of each class	Trading Symbol(s)	Name of each exchange on which registered
Common Stock, $0.625 par value	**APA**	**New York Stock Exchange, Chicago Stock Exchange and NASDAQ Global Select Market**
7.75% Notes Due 2029	**APA/29**	**New York Stock Exchange**

Indicate by check mark whether the registrant is an emerging growth company as defined in Rule 405 of the Securities Act of 1933 (§230.405 of this chapter) or Rule 12b-2 of the Securities Exchange Act of 1934 (§240.12b-2 of this chapter).

Emerging growth company ☐

If an emerging growth company, indicate by check mark if the registrant has elected not to use the extended transition period for complying with any new or revised financial accounting standards provided pursuant to Section 13(a) of the Exchange Act. ☐

The information in this Current Report on Form 8-K, including Exhibit 99.1 furnished herewith, is being furnished and shall not be deemed "filed" for purposes of Section 18 of the Exchange Act or otherwise subject to the liabilities of Section 18, and shall not be incorporated by reference in any filing under the Securities Act or the Exchange Act, except as set forth by specific reference in such filing.

Item 2.02. Results of Operations and Financial Condition.

On February 26, 2020, Apache Corporation issued a press release announcing financial and operating results for the fiscal quarter and year ended December 31, 2019. The full text of the press release is furnished herewith as Exhibit 99.1 and incorporated herein by reference.

Item 9.01. Financial Statements and Exhibits.

(d) Exhibits.

Exhibit No.	Description
99.1	Press Release of Apache Corporation dated February 26, 2020.
104	Cover Page Interactive Data File (embedded within the Inline XBRL document).

SIGNATURES

Pursuant to the requirements of the Securities Exchange Act of 1934, the registrant has duly caused this report to be signed on its behalf by the undersigned hereunto duly authorized.

APACHE CORPORATION

Date: February 27, 2020

By: /s/ Rebecca A. Hoyt
Rebecca A. Hoyt
Senior Vice President, Chief Accounting Officer, and Controller
(Principal Accounting Officer)

Exhibit 99.1

NEWS RELEASE

**Apache Corporation Announces Fourth-Quarter and Full-Year 2019
Financial and Operational Results**

Highlights

- *Delivered fourth-quarter reported production of 487,000 barrels of oil equivalent (BOE) per day; adjusted production, which excludes Egypt noncontrolling interest and tax barrels, was 430,000 BOE per day, exceeding the high end of guidance by 5,000 BOE per day;*
- *Achieved the highest quarterly Permian oil production rate in Apache history, averaging 103,000 barrels per day during the fourth quarter;*
- *Reduced capital investment in 2019 by 23% over 2018, while increasing total company adjusted production by nearly 5%, U.S. production by more than 7%, and Permian oil production by 6% year over year;*
- *Reported full-year net cash from operating activities of $2.9 billion and adjusted EBITDAX of $4.0 billion;*
- *Generated full-year cash return on invested capital on-target with the corporate incentive compensation goal of 19%;*
- *Signed a 50-50 joint venture agreement with Total S.A. for Block 58 offshore Suriname that significantly reduces Apache's potential large-scale appraisal and development capital requirements;*
- *Drilled the Maka Central-1 well in Block 58 Suriname and announced a significant oil discovery in January 2020; currently drilling an exploration well at Sapakara West;*
- *Launched a comprehensive corporate redesign to further align the organization, work processes and cost structure with long-term planned activity levels, targeting a minimum annual savings of $150 million;*
- *Advanced sustainability efforts by initiating alignment with SASB and TCFD reporting standards, beginning to link ESG performance to short-term incentive compensation, and earmarking capital specifically for sustainability projects; and*
- *Establishing 2020 upstream capital investment budget of $1.6 billion to $1.9 billion, a 26% year-over-year decrease at the midpoint; projecting flat to low single digit corporate oil growth on an adjusted basis.*

HOUSTON, Feb. 26, 2020 – Apache Corporation (NYSE, Nasdaq: APA) today announced its financial and operational results for the fourth-quarter and full-year 2019.

Apache reported a loss of $3.0 billion or $7.89 per diluted common share during the fourth-quarter 2019. When adjusted for certain items that impact the comparability of results, including primarily the impact of asset impairments in both the upstream assets in Alpine High and gathering, processing, and transmission assets from the consolidated results of Altus Midstream, Apache's fourth-quarter income totaled $31 million, or $0.08 per share. Net cash provided by operating activities in the fourth quarter was $778 million, and adjusted EBITDAX was $1.1 billion.

For the full-year 2019, Apache reported a loss of $3.6 billion, or $9.43 per diluted common share. On an adjusted basis, Apache’s 2019 earnings totaled $2 million. Net cash provided by operating activities was $2.9 billion, and adjusted EBITDAX was $4.0 billion.

“Apache finished 2019 on a strong note. For the year, we achieved our corporate returns objective and came in below our upstream capital investment target of $2.4 billion. During the fourth quarter, our Permian region delivered the highest oil production in company history at 103,000 barrels per day and exceeded guidance. In December, we signed a joint venture agreement with Total in Block 58 offshore Suriname, which brings in a world-class offshore operator and enables Apache to retain a 50% working interest in the block while significantly reducing our potential exposure to large-scale appraisal and development costs. Our subsequent announcement of a significant oil discovery with the Maka Central-1 well in January 2020 underscores the transformational potential of Suriname Block 58. We are currently drilling the second well on Block 58, Sapakara West-1, and are encouraged by what we’ve seen so far. We will provide more information after reaching total depth and completing our analysis,” said John J. Christmann IV, Apache’s chief executive officer and president.

Christmann continued, “Despite steady progress on many fronts in 2019, we also encountered some significant challenges, most notably around deteriorating natural gas and NGL prices and the performance of our multi-well development pad tests at Alpine High. To further align our investment program with these dynamics, we plan to significantly reduce our spending in 2020, predominantly in Alpine High.

“Apache is well-prepared to navigate this challenging and volatile commodity price environment. We are continuing to streamline our portfolio, completing our comprehensive corporate redesign to centralize and align the organization and costs with projected long-term activity levels, investing to improve long-term returns and free cash flow, strengthening our balance sheet, and sustaining our dividend.

"While these steps are important to generate long-term returns, we must continue to deliver energy in a responsible manner and are taking a number of steps to prioritize ESG initiatives."

Specifically, over the last year, the company started to link ESG performance to short-term incentive compensation, earmarked 2020 capital specifically for sustainability projects, and began to align its 2019 sustainability report with the Task Force on Climate-related Financial Disclosures' (TCFD) recommendations and the Sustainability Accounting Standards Board's (SASB) Oil and Gas Exploration and Production Sustainability Accounting Standard.

2020 capital budget and outlook

In 2020, the company plans to invest $1.6 billion to $1.9 billion in upstream oil and gas capital, which, at the midpoint, represents a 26% reduction from 2019. If oil prices deteriorate from current levels, Apache is prepared to further reduce activity and capital investment. At higher oil prices, the priority will be to retain cash for debt reduction. The company does not anticipate increasing capital investment above $1.9 billion. This 2020 capital budget is projected to deliver flat to low single-digit total company oil production growth on an adjusted basis.

"Apache's portfolio is differentiated through both geographic diversification and an attractive balance of conventional and unconventional development opportunities. We have optionality to fund high-quality, shorter-cycle growth projects in the Permian Basin, Egypt and the North Sea, as well as longer-cycle organic exploration plays. We are choosing to allocate capital to Suriname over the next several years that could otherwise be directed toward near-term growth opportunities elsewhere in the portfolio. This is consistent with our strategy of investing for long-term returns with growth as an outcome," Christmann concluded.

Fourth-quarter operational summary

During the fourth quarter, Apache operated an average of 21 rigs and drilled and completed 74 gross-operated wells worldwide. Highlights from Apache's principal areas include:

- **United States** – Operated an average of eight rigs, drilled and completed 56 gross-operated wells, all of which were in the Permian, and reported production of 299,000 BOE per day, an increase of 5% over fourth-quarter 2018.

  Permian Basin production averaged 288,000 BOE per day, including oil production of 103,000 barrels of oil per day.
  - **Midland Basin** – Averaged four rigs and placed 19 wells on production, all on multi-well pads. The 16-well Lynch-Tippett pad at Wildfire delivered strong initial production rates with an 83% oil cut on 1.5-mile laterals.
  - **Delaware Basin** – Averaged four rigs and placed 36 wells on production, including the 6-well Ghost Rider pad in Lea County, which produced impressive initial flow rates. At year-end, there were no rigs drilling at Alpine High.
- **International** – Operated an average of 13 rigs, drilled and completed 18 gross-operated wells and reported production of 189,000 BOE per day.
  - **Egypt** – Averaged nine rigs, drilled and completed 16 gross-operated wells and reported production of 126,000 BOE per day, or 69,000 BOE per day on an adjusted basis. The company drilled several high-rate oil wells in the Faghur and Shushan basins and had an 81% success rate during the quarter.
  - **North Sea** – Averaged three rigs and drilled and completed two gross operated wells during the quarter with a 100% success rate. Production was 63,000 BOE per day with the startup of the Storr development in late November and return from scheduled turnaround activity in the third quarter.
  - **Suriname** – Drilled the first well in Block 58, the Maka Central-1, during the back half of 2019, and subsequently announced a significant oil discovery in January. The company is now working with its partner Total on an appraisal plan, which will be submitted to the state-owned oil company, Staatsolie, in the coming months.

Drilling commenced in January and is ongoing on the Sapakara West-1 exploration well in Suriname Block 58, approximately 12 miles southeast of the Maka Central-1 discovery. The company has drilled through the shallower Campanian interval and drilling continues toward the deeper Santonian objectives. Once the well reaches total depth, the company will run open-hole logs, pressure tests, fluid and core samples, and associated laboratory analyses. Following Sapakara, the rig will drill a third, and likely a fourth exploration test in Block 58.

Year-end 2019 proved reserves

Worldwide estimated proved reserves totaled 1.01 billion BOE at year-end 2019. During the year, Apache added approximately 176.4 million BOE in field extensions and discoveries, more than offsetting production of approximately 172.9 million BOE. Divestitures reduced proved reserves by 107.6 million BOE. Negative price revisions, partially offset by positive performance revisions, further reduced proved reserves by 119.5 million BOE. More than 88% of Apache’s estimated proved reserves at year-end 2019 were classified as proved developed.

Conference call

Apache will host a conference call to discuss its fourth-quarter and full-year 2019 results at 10 a.m. Central time, Thursday, Feb. 27. The conference call will be webcast from Apache’s website at www.apachecorp.com and investor.apachecorp.com, and the webcast replay will be archived there as well. The conference call will also be available for playback by telephone for one week beginning at approximately 4 p.m. Central time Feb. 28. The number for the replay is 855-859-2056 or 404-537-3406 for international calls. The conference access code is 7162078. Sign up for email alerts to be reminded of the webcast at http://investor.apachecorp.com/alerts/email-alerts-subscription.

About Apache

Apache Corporation is an oil and gas exploration and production company with operations in the United States, Egypt and the United Kingdom and exploration activities offshore Suriname. Apache posts announcements, operational updates, investor information and all press releases on its website, www.apachecorp.com.

Additional information

Additional information follows, including reconciliations of adjusted earnings, adjusted EBITDAX and net debt (non-GAAP financial measures) to GAAP measures and information regarding adjusted production. Apache's quarterly supplement is available at www.apachecorp.com/financialdata.

Non-GAAP financial measures

Apache's financial information includes information prepared in conformity with generally accepted accounting principles (GAAP) as well as non-GAAP financial information. It is management's intent to provide non-GAAP financial information to enhance understanding of our consolidated financial information as prepared in accordance with GAAP. Adjusted earnings, adjusted EBITDAX and net debt are non-GAAP measures. This non-GAAP information should be considered by the reader in addition to, but not instead of, the financial statements prepared in accordance with GAAP. Each non-GAAP financial measure is presented along with the corresponding GAAP measure so as not to imply that more emphasis should be placed on the non-GAAP measure.

Forward-looking statements

This news release contains forward-looking statements within the meaning of Section 27A of the Securities Act of 1933 and Section 21E of the Securities Exchange Act of 1934. Forward-looking statements can be identified by words such as "anticipates," "intends," "plans," "seeks," "believes," "continues," "could," "estimates,"

"expects," "guidance," "may," "might," "outlook," "possibly," "potential," "projects," "should," "will," "would," and similar references to future periods, but the absence of these words does not mean that a statement is not forward-looking. These statements include, but are not limited to, statements about future plans, expectations and objectives for Apache's operations, including statements about our capital plans, drilling plans, production expectations, asset sales, and monetizations. While forward-looking statements are based on assumptions and analyses made by us that we believe to be reasonable under the circumstances, whether actual results and developments will meet our expectations and predictions depend on a number of risks and uncertainties which could cause our actual results, performance, and financial condition to differ materially from our expectations. See "Risk Factors" in our 2018 Form 10-K and in our quarterly reports on Form 10-Q filed, and 2019 Form 10-K when filed, with the Securities and Exchange Commission ("SEC") for a discussion of risk factors that affect our business. Any forward-looking statement made by Apache in this news release speaks only as of the date on which it is made. Factors or events that could cause our actual results to differ may emerge from time to time, and it is not possible for us to predict all of them. Apache undertakes no obligation to publicly update any forward-looking statement, whether as a result of new information, future development or otherwise, except as may be required by law.

Cautionary note to investors

The United States Securities and Exchange Commission permits oil and gas companies, in their filings with the SEC, to disclose only proved, probable, and possible reserves that meet the SEC's definitions for such terms. Apache may use certain terms in this news release, such as "resources," "potential resources," "resource potential," "estimated net reserves," "recoverable reserves," and other similar terms that the SEC guidelines strictly prohibit Apache from including in filings with the SEC. Such terms do not take into account the certainty of resource recovery, which is contingent on exploration success, technical improvements in drilling access, commerciality and other factors, and are therefore not indicative of expected future resource recovery and should not be relied upon. Investors are urged to consider carefully the disclosure in Apache's Annual Report on Form 10-K for the fiscal year ended Dec. 31, 2018 (and Apache's Annual Report on Form 10-K for the fiscal year ended Dec. 31, 2019, when filed) available from Apache at www.apachecorp.com or by writing Apache at: 2000 Post Oak Blvd., Suite 100, Houston, TX 77056 (Attn: Corporate Secretary). You can also obtain this report from the SEC by calling 1-800-SEC-0330 or from the SEC's website at www.sec.gov.

Contacts

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Media: (713) 296-7276 Phil West

Website: www.apachecorp.com

APA-F

-end-

APACHE CORPORATION
STATEMENT OF CONSOLIDATED OPERATIONS
(Unaudited)
(In millions, except per share data)

	For the Quarter Ended December 31, 2019	For the Quarter Ended December 31, 2018	For the Year Ended December 31, 2019	For the Year Ended December 31, 2018
REVENUES AND OTHER:				
Oil and gas production revenues				
Oil revenues	$ 1,316	$ 1,322	$ 5,230	$5,846
Natural gas revenues	188	244	678	919
Natural gas liquids revenues	121	137	407	583
	1,625	1,703	6,315	7,348
Gain on divestitures	23	13	43	23
Other	48	49	53	53
	1,696	1,765	6,411	7,424
OPERATING EXPENSES:				
Lease operating expenses	343	352	1,447	1,439
Gathering, processing and transmission	76	88	306	348
Taxes other than income	66	53	207	215
Exploration	585	252	805	503
General and administrative	83	101	406	431
Transaction, reorganization and separation	33	8	50	28
Depreciation, depletion and amortization:				
Oil and gas property and equipment	676	599	2,512	2,265
Other assets	45	35	168	140
Asset retirement obligation accretion	27	27	107	108
Impairments	2,700	501	2,949	511
Financing costs, net	97	93	462	478
	4,731	2,109	9,419	6,466
NET INCOME BEFORE INCOME TAXES	(3,035)	(344)	(3,008)	958
Current income tax provision	146	185	660	894
Deferred income tax provision (benefit)	66	(179)	14	(222)
NET INCOME (LOSS) INCLUDING NONCONTROLLING INTEREST	(3,247)	(350)	(3,682)	286
Net income attributable to noncontrolling interest - Egypt	42	30	167	245
Net loss attributable to noncontrolling interest - Altus	(329)	1	(334)	1
Net income attributable to Altus Preferred Unit limited partners	16	—	38	—
NET INCOME (LOSS) ATTRIBUTABLE TO COMMON STOCK	$ (2,976)	$ (381)	$(3,553)	$ 40
NET INCOME (LOSS) PER COMMON SHARE:				
Basic	$ (7.89)	$ (1.00)	$ (9.43)	$ 0.11
Diluted	$ (7.89)	$ (1.00)	$ (9.43)	$ 0.11
WEIGHTED-AVERAGE NUMBER OF COMMON SHARES OUTSTANDING:				
Basic	377	379	377	382
Diluted	377	379	377	384
DIVIDENDS DECLARED PER COMMON SHARE	$ 0.25	$ 0.25	$ 1.00	$ 1.00

APACHE CORPORATION
PRODUCTION INFORMATION

	For the Quarter Ended			% Change		For the Year Ended	
	December 31, 2019	September 30, 2019	December 31, 2018	4Q19 to 3Q19	4Q19 to 4Q18	December 31, 2019	December 31, 2018
OIL VOLUME - Barrels per day							
Permian	103,275	94,873	98,560	9%	5%	96,997	91,132
MidContinent/Gulf Coast	2,500	2,635	9,697	-5%	-74%	5,328	10,434
Gulf of Mexico	2,655	2,537	2,391	5%	11%	2,726	3,234
United States	108,430	100,045	110,648	8%	-2%	105,051	104,800
Egypt (1, 2)	79,119	84,114	86,103	-6%	-8%	84,617	93,656
North Sea	50,226	44,281	52,519	13%	-4%	49,746	46,953
International (1)	129,345	128,395	138,622	1%	-7%	134,363	140,609
Total (1)	237,775	228,440	249,270	4%	-5%	239,414	245,409
NATURAL GAS VOLUME - Mcf per day							
Permian	635,159	539,132	553,945	18%	15%	571,141	458,564
MidContinent/Gulf Coast	12,001	14,779	120,720	-19%	-90%	57,996	125,488
Gulf of Mexico	11,235	9,251	7,477	21%	50%	10,443	9,202
United States	658,395	563,162	682,142	17%	-3%	639,580	593,254
Egypt (1, 2)	275,811	275,569	291,196	0%	-5%	285,972	326,811
North Sea	63,681	47,875	55,955	33%	14%	54,642	45,466
International (1)	339,492	323,444	347,151	5%	-2%	340,614	372,277
Total (1)	997,887	886,606	1,029,293	13%	-3%	980,194	965,531
NGL VOLUME - Barrels per day							
Permian	78,908	69,703	45,053	13%	75%	62,106	43,368
MidContinent/Gulf Coast	1,211	1,959	13,676	-38%	-91%	6,017	13,780
Gulf of Mexico	286	343	397	-17%	-28%	258	303
United States	80,405	72,005	59,126	12%	36%	68,381	57,451
Egypt (1, 2)	788	891	877	-12%	-10%	931	923
North Sea	1,920	1,540	1,476	25%	30%	1,739	1,189
International (1)	2,708	2,431	2,353	11%	15%	2,670	2,112
Total	83,113	74,436	61,479	12%	35%	71,051	59,563
BOE per day							
Permian	288,043	254,432	235,936	13%	22%	254,293	210,926
MidContinent/Gulf Coast	5,711	7,057	43,493	-19%	-87%	21,011	45,129
Gulf of Mexico	4,813	4,421	4,035	9%	19%	4,725	5,071
United States	298,567	265,910	283,464	12%	5%	280,029	261,126
Egypt (1, 2)	125,875	130,934	135,513	-4%	-7%	133,209	149,048
North Sea	62,760	53,800	63,321	17%	-1%	60,592	55,719
International (1)	188,635	184,734	198,834	2%	-5%	193,801	204,767
Total (1)	487,202	450,644	482,298	8%	1%	473,830	465,893
Total excluding noncontrolling interests	445,209	406,926	437,030	9%	2%	429,377	416,150

(1) Includes net production volumes attributed to our noncontrolling partner in Egypt below:

Oil (b/d)	26,384	28,052	28,756			28,220	31,240
Gas (Mcf/d)	92,075	92,212	97,317			95,539	109,169
NGL (b/d)	263	297	292			310	308
(2) Egypt Gross Production - BOE per day	300,136	301,296	334,992	0%	-10%	313,722	336,125

APACHE CORPORATION
ADJUSTED PRODUCTION INFORMATION

Adjusted production excludes certain items that management believes affect the comparability of operating results for the periods presented. Adjusted production excludes production attributable to 1) noncontrolling interest in Egypt and 2) Egypt tax barrels. Management uses adjusted production to evaluate the company's operational trends and performance and believes it is useful to investors and other third parties.

	For the Quarter Ended			% Change		For the Year Ended	
	December 31, 2019	September 30, 2019	December 31, 2018	4Q19 to 3Q19	4Q19 to 4Q18	December 31, 2019	December 31, 2018
OIL VOLUME - Barrels per day							
Permian	103,275	94,873	98,560	9%	5%	96,997	91,132
MidContinent/Gulf Coast	2,500	2,635	9,697	-5%	-74%	5,328	10,434
Gulf of Mexico	2,655	2,537	2,391	5%	11%	2,726	3,234
United States	108,430	100,045	110,648	8%	-2%	105,051	104,800
Egypt	42,120	44,461	46,077	-5%	-9%	44,773	47,286
North Sea	50,226	44,281	52,519	13%	-4%	49,746	46,953
International	92,346	88,742	98,596	4%	-6%	94,519	94,239
Total	200,776	188,787	209,244	6%	-4%	199,570	199,039
NATURAL GAS VOLUME - Mcf per day							
Permian	635,159	539,132	553,945	18%	15%	571,141	458,564
MidContinent/Gulf Coast	12,001	14,779	120,720	-19%	-90%	57,996	125,488
Gulf of Mexico	11,235	9,251	7,477	21%	50%	10,443	9,202
United States	658,395	563,162	682,142	17%	-3%	639,580	593,254
Egypt	159,242	160,263	166,109	-1%	-4%	165,159	180,841
North Sea	63,681	47,875	55,955	33%	14%	54,642	45,466
International	222,923	208,138	222,064	7%	0%	219,801	226,307
Total	881,318	771,300	904,206	14%	-3%	859,381	819,561
NGL VOLUME - Barrels per day							
Permian	78,908	69,703	45,053	13%	75%	62,106	43,368
MidContinent/Gulf Coast	1,211	1,959	13,676	-38%	-91%	6,017	13,780
Gulf of Mexico	286	343	397	-17%	-28%	258	303
United States	80,405	72,005	59,126	12%	36%	68,381	57,451
Egypt	474	518	527	-8%	-10%	550	505
North Sea	1,920	1,540	1,476	25%	30%	1,739	1,189
International	2,394	2,058	2,003	16%	20%	2,289	1,694
Total	82,799	74,063	61,129	12%	35%	70,670	59,145
BOE per day							
Permian	288,043	254,432	235,936	13%	22%	254,293	210,926
MidContinent/Gulf Coast	5,711	7,057	43,493	-19%	-87%	21,011	45,129
Gulf of Mexico	4,813	4,421	4,035	9%	19%	4,725	5,071
United States	298,567	265,910	283,464	12%	5%	280,029	261,126
Egypt	69,134	71,690	74,289	-4%	-7%	72,850	77,932
North Sea	62,760	53,800	63,321	17%	-1%	60,592	55,719
International	131,894	125,490	137,610	5%	-4%	133,442	133,651
Total	430,461	391,400	421,074	10%	2%	413,471	394,777

APACHE CORPORATION
PRICE INFORMATION

	For the Quarter Ended			For the Year Ended	
	December 31, 2019	September 30, 2019	December 31, 2018	December 31, 2019	December 31, 2018
AVERAGE OIL PRICE PER BARREL					
Permian	$ 56.25	$ 54.51	$ 50.98	$ 54.47	$ 58.57
MidContinent/Gulf Coast	56.97	58.38	58.73	56.77	64.17
Gulf of Mexico	56.47	58.38	61.48	59.44	67.75
United States	56.26	54.70	51.85	54.71	59.36
Egypt	63.11	61.10	64.27	63.76	70.09
North Sea	64.07	63.12	62.68	65.10	69.02
International	63.48	61.75	63.69	64.25	69.73
Total	60.19	58.60	58.37	60.05	65.30
AVERAGE NATURAL GAS PRICE PER MCF					
Permian	$ 1.47	$ .91	$ 1.71	$ 1.11	$ 1.95
MidContinent/Gulf Coast	2.30	2.03	3.32	2.47	2.65
Gulf of Mexico	2.43	2.39	3.70	2.76	3.27
United States	1.50	0.97	2.03	1.26	2.12
Egypt	2.86	2.81	2.83	2.83	2.84
North Sea	4.30	3.20	7.91	4.48	7.33
International	3.13	2.87	3.65	3.09	3.39
Total	2.05	1.66	2.57	1.90	2.61
AVERAGE NGL PRICE PER BARREL					
Permian	$ 14.93	$ 13.24	$ 24.29	$ 14.82	$ 27.20
MidContinent/Gulf Coast	16.60	14.35	22.17	16.05	23.32
Gulf of Mexico	21.39	16.11	24.47	19.16	29.82
United States	15.00	13.26	23.81	14.95	26.28
Egypt	36.47	27.76	34.43	33.87	39.17
North Sea	44.22	26.63	42.94	36.83	45.84
International	41.97	27.05	39.77	35.80	42.93
Total	15.88	13.71	24.42	15.74	26.87

APACHE CORPORATION
SUPPLEMENTAL FINANCIAL INFORMATION
(Unaudited)
(In millions)

SUMMARY EXPLORATION EXPENSE INFORMATION

	For the Quarter Ended December 31,		For the Year Ended December 31,	
	2019	2018	2019	2018
Unproved leasehold impairments	$545	$ 138	$619	$ 214
Dry hole expense	24	80	57	137
Geological and geophysical expense	5	14	59	55
Exploration overhead and other	11	20	70	97
	$585	$ 252	$805	$ 503

SUMMARY CASH FLOW INFORMATION

	For the Quarter Ended December 31,		For the Year Ended December 31,	
	2019	2018	2019	2018
Net cash provided by operating activities	$ 778	$ 1,043	$ 2,867	$ 3,777
Additions to upstream oil and gas property	(580)	(899)	(2,634)	(3,323)
Additions to Altus gathering, processing, and transmission facilities	(33)	(169)	(327)	(581)
Altus equity method interests	(164)	(91)	(1,172)	(91)
Proceeds from sale of oil and gas properties	128	87	718	138
Other, net	(14)	(32)	(31)	(87)
Net cash used in investing activities	$(663)	$(1,104)	$(3,446)	$(3,944)
Debt borrowings and payments, net	161	—	235	(378)
Proceeds from Altus transaction	—	628	—	628
Distributions to noncontrolling interest - Egypt	(70)	(89)	(305)	(345)
Redeemable noncontrolling interest - Altus Preferred Unit limited partners	—	—	611	—
Dividends paid	(94)	(95)	(376)	(382)
Other	(28)	(262)	(53)	(310)
Net cash used in financing activities	$ (31)	$ 182	$ 112	$ (787)

SUMMARY BALANCE SHEET INFORMATION

	December 31, 2019	December 31, 2018
Cash and cash equivalents	$ 247	$ 714
Other current assets	1,714	1,973
Property and equipment, net	14,158	18,421
Other assets	1,988	474
Total assets	$ 18,107	$ 21,582
Current debt - Apache *	$ 1	$ 151
Current debt - Altus	10	—
Current liabilities	1,844	2,050
Long-term debt - Apache *	8,159	8,093
Long-term debt - Altus	396	—
Deferred credits and other noncurrent liabilities	2,677	2,476
Redeemable noncontrolling interest - Altus Preferred Unit limited partners	555	—
Apache shareholders' equity	3,255	7,130
Noncontrolling interest - Egypt	1,137	1,275
Noncontrolling interest - Altus	73	407
Total Liabilities, redeemable noncontrolling interest, and equity	$ 18,107	$ 21,582
Common shares outstanding at end of period	377	375

* Excludes Altus

APACHE CORPORATION
NON-GAAP FINANCIAL MEASURES
(In millions, except per share data)

Reconciliation of Net cash provided by operating activities to Adjusted EBITDAX

Management believes EBITDAX, or earnings before income tax expense, interest expense, depreciation, amortization and exploration expense is a widely accepted financial indicator, and useful for investors, to assess a company's ability to incur and service debt, fund capital expenditures, and make distributions to shareholders. We define adjusted EBITDAX, a non-GAAP financial measure, as EBITDAX adjusted for certain items presented in the accompanying reconciliation. Management uses adjusted EBITDAX to evaluate our ability to fund our capital expenditures, debt services and other operational requirements and to compare our results from period to period by eliminating the impact of certain items that management does not consider to be representative of the Company's on-going operations. Management also believes adjusted EBITDAX facilitates investors and analysts in evaluating and comparing EBITDAX from period to period by eliminating differences caused by the existence and timing of certain operating expenses that would not otherwise be apparent on a GAAP basis. However, our presentation of adjusted EBITDAX may not be comparable to similar measures of other companies in our industry.

	For the Quarter Ended			For the Year Ended	
	December 31, 2019	September 30, 2019	December 31, 2018	December 31, 2019	2018
Net cash provided by operating activities	$ 778	$ 635	$ 1,043	$2,867	$3,777
Adjustments:					
Exploration seismic and administration costs	16	39	34	129	152
Current income tax provision	146	141	185	660	894
Other adjustments to reconcile net income to net cash provided by operating activities	(19)	(13)	(29)	(50)	(125)
Changes in operating assets and liabilities	42	1	(191)	3	(245)
Financing costs, net (excluding loss on early extinguishment of debt)	97	95	93	387	384
Transaction, reorganization & separation costs	33	7	8	50	28
Adjusted EBITDAX (Non-GAAP)	$ 1,093	$ 905	$ 1,143	$4,046	$4,865

Reconciliation of Income attributable to common stock to Adjusted earnings

Our presentation of adjusted earnings and adjusted earnings per share are non-GAAP measures because they exclude the effect of certain items included in Income Attributable to Common Stock. Management believes that adjusted earnings and adjusted earnings per share provides relevant and useful information, which is widely used by analysts, investors and competitors in our industry as well as by our management in assessing the Company's operational trends and comparability of results to our peers.

Management uses adjusted earnings and adjusted earnings per share to evaluate our operating and financial performance because it eliminates the impact of certain items that management does not consider to be representative of the Company's on-going business operations. As a performance measure, adjusted earnings may be useful to investors in facilitating comparisons to others in the Company's industry because certain items can vary substantially in the oil and gas industry from company to company depending upon accounting methods, book value of assets, capital structure and asset sales and other divestitures, among other factors. Management believes excluding these items facilitates investors and analysts in evaluating and comparing the underlying operating and financial performance of our business from period to period by eliminating differences caused by the existence and timing of certain expense and income items that would not otherwise be apparent on a GAAP basis. However, our presentation of adjusted earnings and adjusted earnings per share may not be comparable to similar measures of other companies in our industry.

	For the Quarter Ended December 31, 2019				For the Quarter Ended December 31, 2018			
	Before Tax	Tax Impact	After Tax	Diluted EPS	Before Tax	Tax Impact	After Tax	Diluted EPS
Income including noncontrolling interest (GAAP)	$(3,035)	$ (212)	$(3,247)	$ (8.61)	$ (344)	$ (6)	$(350)	$ (0.92)
Income attributable to noncontrolling interest	(191)	(96)	(287)	(0.77)	71	(40)	31	0.08
Loss attributable to Altus preferred unit limited partner	16	—	16	0.05	—	—	—	—
Net income attributable to common stock	(2,860)	(116)	(2,976)	(7.89)	(415)	34	(381)	(1.00)
Adjustments:*								
Asset impairments	3,245	(682)	2,563	6.78	639	(143)	496	1.31
Noncontrolling interest impact on Altus impairments	(269)	57	(212)	(0.56)	—	—	—	—
Noncontrolling interest & tax barrel impact on Egypt adj	—	—	—	—	13	(34)	(21)	(0.06)
Valuation allowance and other tax adjustments	—	655	655	1.74	—	42	42	0.10
Loss on extinguishment of debt	—	—	—	—	—	—	—	—
Unrealized derivative instrument (gain)/loss	(8)	1	(7)	(0.02)	(15)	2	(13)	(0.03)
Transaction, reorganization & separation costs	33	(7)	26	0.07	8	(3)	5	0.01
Modification of stock comp plans	—	—	—	—	—	—	—	—
(Gain)/loss on divestitures	(23)	5	(18)	(0.04)	(13)	4	(9)	(0.02)
Adjusted earnings (Non-GAAP)	$ 118	$ (87)	$ 31	$ 0.08	$ 217	$ (98)	$ 119	$ 0.31

	For the Year Ended December 31, 2019				For the Year Ended December 31, 2018			
	Before Tax	Tax Impact	After Tax	Diluted EPS	Before Tax	Tax Impact	After Tax	Diluted EPS
Income including noncontrolling interest (GAAP)	$(3,008)	$ (674)	$(3,682)	$ (9.77)	$ 958	$ (672)	$ 286	$ 0.75
Income attributable to noncontrolling interest	44	(211)	(167)	(0.44)	464	(218)	246	0.64
Loss attributable to Altus preferred unit limited partner	38	—	38	0.10	—	—	—	—
Net income attributable to common stock	(3,090)	(463)	(3,553)	(9.43)	494	(454)	40	0.11
Adjustments:*								
Asset impairments	3,568	(750)	2,818	7.45	725	(163)	562	1.47

Noncontrolling interest impact on Altus impairments	(271)	57	(214)	(0.56)	—	—	—	—
Noncontrolling interest & tax barrel impact on Egypt adj	—	—	—	—	13	(34)	(21)	(0.05)
Valuation allowance and other tax adjustments	—	854	854	2.27	—	72	72	0.18
Loss on extinguishment of debt	75	(16)	59	0.16	94	(19)	75	0.19
Unrealized derivative instrument (gain)/loss	44	(11)	33	0.09	(103)	21	(82)	(0.21)
Transaction, reorganization & separation costs	50	(11)	39	0.11	28	(7)	21	0.06
Modification of stock comp plans	—	—	—	—	39	(9)	30	0.07
(Gain)/loss on divestitures	(43)	9	(34)	(0.09)	(23)	5	(18)	(0.05)
Adjusted Earnings (Non-GAAP)	$ 333	$ (331)	$ 2	$ 0.00	$ 1,267	$ (588)	$ 679	$ 1.77

* The income tax effect of the reconciling items are calculated based on the statutory rate of the jurisdiction in which the discrete item resides.

APACHE CORPORATION
NON-GAAP FINANCIAL MEASURES
(In millions)

Reconciliation of Costs incurred to Upstream capital investment

Management believes the presentation of upstream capital investments is useful for investors to assess Apache's expenditures related to our upstream capital activity. We define capital investments as costs incurred for oil and gas activities, adjusted to exclude asset retirement obligation revisions and liabilities incurred, capitalized interest, and certain exploration expenses, while including amounts paid during the period for abandonment and decommissioning expenditures. Upstream capital expenditures attributable to a one-third noncontrolling interest in Egypt are also excluded. Management believes this provides a more accurate reflection of Apache's cash expenditures related to upstream capital activity and is consistent with how we plan our capital budget.

	For the Quarter Ended December 31,		For the Year Ended December 31,	
	2019	2018	2019	2018
Costs incurred in oil and gas property:				
Acquisitions				
Proved	$ 1	$ 1	$ 8	$ 6
Unproved	14	46	57	127
Exploration and development	533	860	2,464	3,321
Total Costs incurred in oil and gas property	$548	$907	$2,529	$3,454
Reconciliation of Costs incurred to Upstream capital investment:				
Total Costs incurred in oil and gas property	$548	$907	$2,529	$3,454
Asset retirement obligations settled vs. incurred - oil and gas property	110	(1)	153	20
Capitalized interest	(8)	(8)	(32)	(36)
Exploration seismic and administration costs	(16)	(34)	(129)	(152)
Less noncontrolling interest - Egypt	(44)	(49)	(155)	(200)
Total Upstream capital investment	$590	$815	$2,366	$3,086

Reconciliation of Net cash provided by operating activities to Cash flows from operations before changes in operating assets and liabilities

Cash flows from operations before changes in operating assets and liabilities is a non-GAAP financial measure. Apache uses it internally and provides the information because management believes it is useful for investors and widely accepted by those following the oil and gas industry as a financial indicator of a company's ability to generate cash to internally fund exploration and development activities, fund dividend programs, and service debt. It is also used by research analysts to value and compare oil and gas exploration and production companies and is frequently included in published research when providing investment recommendations. Cash flows from operations before changes in operating assets and liabilities, therefore, is an additional measure of liquidity but is not a measure of financial performance under GAAP and should not be considered as an alternative to cash flows from operating, investing, or financing activities.

	For the Quarter Ended			For the Year Ended	
	December 31, 2019	September 30, 2019	December 31, 2018	December 31, 2019	December 31, 2018
Net cash provided by operating activities	$ 778	$ 635	$ 1,043	$2,867	$3,777
Changes in operating assets and liabilities	42	1	(191)	3	(245)
Cash flows from operations before changes in operating assets and liabilities	$ 820	$ 636	$ 852	$2,870	$3,532

APACHE CORPORATION
OIL & GAS RESERVES INFORMATION
For the Year Ended December 31, 2019

OIL (Mbbl)	U.S.	Egypt[1]	North Sea	Total[1]
Balance - Dec 31, 2018	345,666	119,498	115,769	580,933
Extensions and Discoveries	52,297	21,039	9,017	82,353
Purchases	—	—	—	—
Revisions	(16,446)	4,752	5,132	(6,562)
Production	(38,344)	(30,885)	(18,157)	(87,386)
Sales	(18,312)	—	—	(18,312)
Balance - Dec 31, 2019	324,861	114,404	111,761	551,026

NGL's (Mbbl)	U.S.	Egypt[1]	North Sea	Total[1]
Balance - Dec 31, 2018	231,370	562	2,569	234,501
Extensions and Discoveries	41,343	27	697	42,067
Purchases	—	—	—	—
Revisions	(32,569)	508	345	(31,716)
Production	(24,959)	(340)	(634)	(25,933)
Sales	(32,822)	—	—	(32,822)
Balance - Dec 31, 2019	182,363	757	2,977	186,097

GAS (MMcf)	U.S.	Egypt[1]	North Sea	Total[1]
Balance - Dec 31, 2018	1,893,493	509,138	111,151	2,513,782
Extensions and Discoveries	249,205	34,758	27,711	311,674
Purchases	—	—	—	—
Revisions	(509,753)	18,570	4,015	(487,168)
Production	(233,447)	(104,380)	(19,944)	(357,771)
Sales	(338,520)	—	—	(338,520)
Balance - Dec 31, 2019	1,060,978	458,086	122,933	1,641,997

TOTAL BOE (Mboe)	U.S.	Egypt[1]	North Sea	Total[1]
Balance - Dec 31, 2018	892,618	204,916	136,863	1,234,397
Extensions and Discoveries	135,174	26,859	14,333	176,366
Purchases	—	—	—	—
Revisions	(133,974)	8,355	6,146	(119,473)
Production	(102,211)	(48,622)	(22,115)	(172,948)
Sales	(107,554)	—	—	(107,554)
Balance - Dec 31, 2019	684,053	191,508	135,227	1,010,788
Proved developed reserves:				
Oil (Mbbls)	278,145	103,573	101,712	483,430
NGL's (Mbbls)	158,794	667	2,317	161,778
Gas (Mboe)	157,656	72,230	17,722	247,608
Balance - Dec 31, 2019 (Mboe)	594,595	176,470	121,751	892,816

(1) Includes reserves attributable to noncontrolling interest in Egypt.

Exhibit 34

Apache Corp

4Q19 Post Mortem and Model Update

Neutral

APA, APA US

Price (27 Feb 20): $25.07

▼ **Price Target (Dec-20): $28.00**
Prior (Dec-20): $30.00

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JPM View: The key takeaway from the call was management's intention to pivot to its longer-cycle growth opportunities in Suriname and Egypt from the Permian, including what amounts to a nail in the coffin for Alpine High (AH) given weak gas and NGL prices and the inability of the company to improve oil productivity at AH. After digesting the company's 4Q19 update and 2020 outlook, APA looks decently positioned, particularly in a lower commodity environment, given the company's conventional assets. APA defines maintenance capex as capital required to maintain oil production and the dividend. They estimate that this equates to $45 per bbl (WTI) over the intermediate term and $48 per bbl over the long-term (~20 year time-frame). At the low-end of the company's $1.6 to $1.9 billion capex budget, the company can sustain flat oil production, fund $200 MM of high-impact exploration potential in Suriname and fund the ~$376 MM per annum dividend (~4.0% yield) at an oil price break-even of $46 to $47 per bbl. In fact, APA believes its cash flow break-even could fall even further, while still first oil at Suriname through the TOTAL carry. Consistent with what we wrote in the earnings flash, management's tone appeared positive on the Sapakara West-1 well, suggesting they may have found pay in the shallower Campanian interval as they are now drilling toward the deeper Santonian objective.

- **2020 production and capex guide:** APA guided to 2020 capex of $1.75 billion, which includes minimal capital allocation to Alpine High, shifting some capital from the Permian to Egypt, and $200 MM of exploration expenses concentrated in Suriname. The company reiterated its confidence in sustaining the dividend (~4.0% yield) and focus on debt reduction if they generate FCF. APA expects to deliver flat to low-single-digit total company oil production growth on an adjusted basis.

- **Corporate reorganization:** APA is knee-deep in its corporate reorganization plan, which will include a permanent reduction in headcount and a more centralized org structure that will tie incentives to asset team performance over regions. APA expects to achieve $150 MM of annual savings and overhead and opex cost reductions from this initiative. The company expects to get to this run rate in 2H20.

Key Changes (FYE Dec)

	Prev	Cur
Adj. EPS - 20E ($)	0.51	(0.15)
Adj. EPS - 21E ($)	(0.04)	0.11

Quarterly Forecasts (FYE Dec)

Adj. EPS ($)

	2019A	2020E	2021E
Q1	0.10	(0.07)	0.05
Q2	0.11	(0.08)	0.02
Q3	(0.29)	(0.03)	0.01
Q4	0.08	0.04	0.04
FY	0.01	(0.15)	0.11

Style Exposure

Quant Factors	Current %Rank	Hist %Rank (1=Top) 6M	1Y	3Y	5Y
Value	79	62	73	79	72
Growth	92	54	61	26	83
Momentum	2	89	85	70	92
Quality	93	85	67	63	70
Low Vol	68	51	52	57	29
ESGQ	29	26	73	20	88

Sources for: Style Exposure – J.P. Morgan Quantitative and Derivatives Strategy; all other tables are company data and J.P. Morgan estimates.

See page 11 for analyst certification and important disclosures, including non-US analyst disclosures.

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Price Performance

	YTD	1m	3m	12m
Abs	-2.6%	-13.3%	7.3%	-24.9%
Rel	6.0%	-3.5%	13.6%	-31.0%

Company Data

Shares O/S (mn)	376
52-week range ($)	38.12-18.33
Market cap ($ mn)	9,370.82
Exchange rate	1.00
Free float(%)	99.6%
3M - Avg daily vol (mn)	6.33
3M - Avg daily val ($ mn)	165.0
Volatility (90 Day)	68
Index	S&P 500
BBG BUY|HOLD|SELL	10|19|2

Key Metrics (FYE Dec)

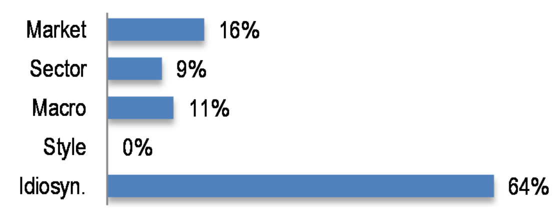
$ in millions	FY19A	FY20E	FY21E
Financial Estimates			
Revenue	6,411	5,557	5,286
Adj. EBITDA	3,237	2,952	2,889
Adj. EBIT	557	617	775
Adj. net income	2	(55)	43
Adj. EPS	0.01	(0.15)	0.11
BBG EPS	(0.13)	0.01	0.33
Cashflow from operations	2,867	2,146	2,105
FCFF	501	396	695
Margins and Growth			
Revenue growth	(13.6%)	(13.3%)	(4.9%)
EBITDA margin	50.5%	53.1%	54.7%
EBITDA growth	(25.8%)	(8.8%)	(2.1%)
EBIT margin	8.7%	11.1%	14.7%
Net margin	0.0%	(1.0%)	0.8%
Adj. EPS growth	(99.7%)	(2849.3%)	(177.7%)
Ratios			
Adj. tax rate	(22.4%)	40.0%	40.0%
Interest cover	7.0	7.5	7.3
Net debt/Equity	1.7	1.7	1.6
Net debt/EBITDA	2.6	2.8	2.8
ROCE	5.1%	3.1%	3.9%
ROE	0.0%	(1.7%)	1.4%
Valuation			
FCFF yield	5.3%	4.2%	7.4%
Dividend yield	-	-	-
EV/EBITDA	6.0	6.6	6.6
Adj. P/E	4,694.3	NM	219.6

Summary Investment Thesis and Valuation

We believe the market began discounting the potential for Suriname discovery when the JV transaction for Total was announced. Since that time, APA shares have outperformed the XOP Index by 9%, which suggests the market has embedded ~$900 MM of value associated with the discovery. Using our HES NAV as a guide, we think the market could give APA credit for $2.2 billion in net value from Suriname or 1.2 BBoe of gross resource potential.

Using our NAV methodology, we calculate a net asset value of $30 per share for Apache (APA). From our analysis, we believe a Neutral rating on APA is justified given resource potential associated with Suriname. Our December 2020 price target of $30, which assumes the stock trades at parity with our NAV estimate. In summary, we value proved developed reserves (net of liabilities) at ~$10 per share and undeveloped/unproven reserves at ~$18 per share to arrive at a total proved developed and undeveloped reserve value of $28 per share.

Performance Drivers



Factors	6M Corr	1Y Corr
Market: MSCI US	0.38	0.47
Sect: Energy	0.19	0.38
Ind: Energy	0.19	0.38
Macro:		
Non-Energy Commodity	0.15	0.12
Crude Oil	-0.08	0.12
Credit Spread	-0.18	-0.11
Quant Styles:		
LowVol	-0.20	-0.18
Momentum	-0.22	-0.18
Value	0.20	0.15

Source: J.P. Morgan Quantitative and Derivatives Strategy for Performance Drivers; company data, Bloomberg and J.P. Morgan estimates for all other tables.

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- **Alpine High:** Management indicated that extended flow tests in 2H19 from multi-well spacing patterns across different landing zones were disappointing. As a result of the sharp decline in gas and NGL prices, APA indicated that further appraisal testing was not warranted at this time. The company dropped its drilling rigs in 4Q19 and has decided to defer completion activity. The company recognized a $1.4 billion impairment to Alpine High wells, facilities, and leasehold, $1.3 billion for Altus Midstream, and $528 MM for Alpine High unproven leasehold assets in exploration. The company contracted for 1 Bcf/d of long-term transportation capacity out of the Permian, but has reduced its take-or-pay obligations by 310 MMcf/d, with incremental liability management anticipated. The company expects slight production declines at Alpine High in 1Q20 from ~95 MBoe/d in 4Q19, with volumes expected to decline to 50 to 60 MBoe/d by 4Q20. Unless there is a meaningful improvement in gas and NGL prices, APA signaled its activities might largely cease at Alpine High as 200K of its 240K acreage position exposure over the next three years as the anticipated uplift in oil productivity did not materialize in the play.

- **Egypt/North Sea:** 4Q19 volumes were negatively impacted by a quarter specific cost recovery settlement in a non-op concession, but management expects no lingering impact into 2020. APA expects to test several high impact oil prospects on new and legacy acreage after interpreting their new seismic data. In the North Sea, production rose by 9 MBoe/d, or 17% sequentially, to reflect the resumption of production post the 3Q19 turnaround and growth from the Storr discovery. APA expects sequential growth in 1Q20 from the Garten 2 well, which is now on-line.

- **Maka Central-1 discovery.** The Maka Central-1 well successfully tested hydrocarbons in multiple stacked targets in two intervals: 1) Upper Cretaceous-aged Campanian interval, containing 50 meters (164 feet) of net hydrocarbon-bearing reservoir with API gravities between 40 and 60 degrees; and 2) Santonian intervals, containing 73 meters (240 feet) of net oil-bearing reservoir with API oil gravities between 35 and 45 degrees. The Maka Central-1 well also targeted a third interval, the Turonian, but due to significantly over-pressured, oil-bearing reservoirs in the lower Santonian, the company concluded its drilling activity at approximately 6,300 meters (20,670 feet). The company is working on an appraisal plan that will be submitted to the state-owned oil company (Staatsolie) in coming months.

- **Current drilling activity in Suriname.** In January, APA started drilling its 2nd Suriname well on Block 58 called Sapakara West-1, which is located approximately 20 kilometers (12 miles) southeast of the Maka Central discovery. APA has drilled through the shallower upper Cretaceous targets in the Campanian and is continuing to drill towards the deeper Santonian intervals. APA has also exercised its option to drill a 3rd well on Block 58. Under the JV agreement, APA will then transfer operatorship to Total. APA will likely exercise its option to drill a 4th Suriname well on the Noble Sam Croft drillship.

- **Estimate revision:** We are revising our estimates to incorporate the 4Q19 earnings release and updated strip pricing. Our 2020/2021 EPS estimates move to ($0.15)/$0.11 from $0.51/($0.04). Our 2020/2021 CFPS estimates move to $5.69/$5.58 from $7.35/$6.49. Our model is based on 2020/2021 oil and gas prices of $50.75/$50.88 per bbl and $2.03/$2.36 per Mcf vs. our prior commodity price assumption of $59.01/$54.36 per bbl and $2.28/$2.20 per Mcf. Our NAV based

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Dec-20 price target moves to $28 from $30 per share, reflecting the reduction in the futures strip.

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Figure 1: APA's Operating Summary

Apache Corp (APA)	2019E					2020E					2021E
JP Morgan Research Estimates	1Q	2Q	3Q	4Q	Year	1Q	2Q	3Q	4Q	Year	Year
Operating Summary											
Benchmark Prices											
Natural Gas ($/Mcf)	$3.15	$2.64	$2.23	$2.50	**$2.63**	$1.84	$1.89	$2.06	$2.27	**$2.03**	**$2.36**
Crude Oil (WTI)--($/Bbl)	$54.87	$59.82	$56.60	$56.96	**$57.06**	$50.28	$50.44	$50.99	$51.12	**$50.75**	**$50.88**
NGLs ($/Bbl)	$22.98	$19.08	$16.32	$18.88	**$19.32**	$15.03	$14.59	$15.14	$15.71	**$15.12**	**$15.38**
Realized Prices											
Natural Gas ($/Mcf)	$2.35	$1.41	$1.66	$2.05	**$1.89**	$1.83	$1.84	$2.03	$2.26	**$1.98**	**$2.30**
Crude Oil ($/Bbl)	$47.21	$58.64	$52.46	$55.61	**$53.44**	$48.48	$48.88	$49.60	$49.80	**$49.18**	**$49.86**
NGLs ($/Bbl)	$18.46	$13.57	$13.26	$15.00	**$14.97**	$10.06	$9.63	$10.18	$10.74	**$10.13**	**$10.42**
Daily Production											
Natural Gas (MMcf/d)	1,117	922	887	998	**981**	995	958	911	885	**937**	**830**
Crude Oil (Mbbl/d)	256.1	236.8	228.4	237.8	**239.8**	243.9	243.1	235.4	238.0	**240.1**	**227.6**
NGLs (Mbbl/d)	61.8	64.5	74.4	83.1	**71.0**	82.9	78.6	73.4	70.0	**76.2**	**64.6**
Total Production (MBoe/d)	502.88	455	451	487	**474**	493	481	461	456	**473**	**431**
% Growth (YoY)	14.2%	-2.0%	-5.4%	1.0%	**1.8%**	-2.0%	5.8%	2.2%	-6.5%	**-0.4%**	**-8.9%**
% Oil Growth (YoY)	6.1%	-4.3%	-6.2%	-4.6%	**-2.3%**	-4.7%	2.7%	3.0%	0.1%	**0.1%**	**-5.2%**
Production Summary											
Natural Gas (Bcf)	101	84	82	92	**358**	91	87	84	81	**343**	**303**
Crude Oil (MMBo)	23.0	21.6	21.0	21.9	**87.5**	22.2	22.1	21.7	21.9	**87.9**	**83.1**
NGLs (MMBo)	5.6	5.9	6.8	7.6	**25.9**	7.5	7.1	6.8	6.4	**27.9**	**23.6**
Total Production (MMBoe)	45	41	41	45	**173**	45	44	42	42	**173**	**157**
% Gas	37.0%	33.8%	32.8%	34.1%	**34.5%**	33.7%	33.2%	33.0%	32.4%	**33.1%**	**32.1%**
% Oil	50.9%	52.0%	50.7%	48.8%	**50.6%**	49.5%	50.5%	51.1%	52.2%	**50.8%**	**52.9%**
% NGL	12.3%	14.2%	16.5%	17.1%	**15.0%**	16.8%	16.3%	15.9%	15.4%	**16.1%**	**15.0%**

Source: J.P. Morgan estimates

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Figure 2: APA's Income Statement Summary

Apache Corp (APA) JP Morgan Research Estimates	2019E 1Q	2019E 2Q	2019E 3Q	2019E 4Q	2019E Year	2020E 1Q	2020E 2Q	2020E 3Q	2020E 4Q	2020E Year	2021E Year
Summary Income Statement											
E&P Revenue (includes hedges)	$1,657	$1,615	$1,438	$1,648	**$6,358**	$1,412	$1,375	$1,370	$1,400	**$5,557**	**$5,286**
Marketing, midstream, and other	($22)	($12)	$39	$48	**$53**	$0	$0	$0	$0	**$0**	**$0**
Total Revenue	$1,635	$1,603	$1,477	$1,696	**$6,411**	$1,412	$1,375	$1,370	$1,400	**$5,557**	**$5,286**
Operating Expenses											
DD&A	$646	$602	$711	$721	**$2,680**	$605	$591	$572	$566	**$2,334**	**$2,114**
Exploration	$69	$95	$56	$585	**$805**	$58	$58	$58	$58	**$230**	**$216**
Asset Retirement Obligation accretion and other	$27	$26	$27	$27	**$107**	$27	$27	$27	$27	**$108**	**$108**
LOE	$365	$389	$350	$343	**$1,447**	$370	$361	$350	$346	**$1,427**	**$1,296**
Gathering & Transportation	$88	$76	$66	$76	**$306**	$75	$74	$71	$70	**$290**	**$264**
Taxes other than income	$51	$46	$44	$66	**$207**	$53	$52	$51	$52	**$208**	**$201**
General and administrative	$123	$102	$98	$83	**$406**	$120	$115	$110	$105	**$450**	**$420**
Impairment abandonment & other	$4	$246	$16	$2,733	**$2,999**	$0	$0	$0	$0	**$0**	**$0**
Total	$1,373	$1,582	$1,368	$4,634	**$8,957**	$1,308	$1,277	$1,239	$1,224	**$5,048**	**$4,618**
Operating Income (EBIT)	$262	$21	$109	($2,938)	**($2,546)**	$105	$98	$131	$176	**$509**	**$667**
Interest expense	$97	$173	$95	$97	**$462**	$97	$99	$99	$99	**$395**	**$397**
Other	$0	$0	$0	$0	**$0**	$0	$0	$0	$0	**$0**	**$0**
Total Other (Income) Expense	$97	$173	$95	$97	**$462**	$97	$99	$99	$99	**$395**	**$397**
Pre-tax income	$165	($152)	$14	($3,035)	**($3,008)**	$8	($1)	$32	$77	**$114**	**$270**
Less: Income taxes	$167	$164	$131	$212	**$674**	$3	($1)	$13	$31	**$46**	**$108**
Less: Preferred dividends	$0	$0	$0	$0	**$0**	$0	$0	$0	$0	**$0**	**$0**
Less: NCI	$45	$44	$53	($271)	**($129)**	$32	$30	$31	$31	**$124**	**$119**
Plus: Discontinued operatoons	$0	$0	$0	$0	**$0**	$0	$0	$0	$0	**$0**	**$0**
Reported net income	($47)	($360)	($170)	($2,976)	**($3,553)**	($28)	($30)	($12)	$15	**($55)**	**$43**
Special items (after-tax)	85	401	62	3,007	**3,555**	0	0	0	0	**0**	**0**
Adjusted Net Income	$38	$41	($108)	$31	**$2**	($28)	($30)	($12)	$15	**($55)**	**$43**
Adjusted EPS (Diluted)	$0.10	$0.11	($0.29)	$0.08	**$0.01**	($0.07)	($0.08)	($0.03)	$0.04	**($0.15)**	**$0.11**
Basic Shares	376	377	377	377	**377**	377	377	377	377	**377**	**377**
Diluted Shares	376	377	377	377	**377**	377	377	377	377	**377**	**377**

Source: J.P. Morgan estimates

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Figure 3: APA's Cash Flow and Balance Sheet Summary

Apache Corp (APA) JP Morgan Research Estimates	2019E 1Q	2019E 2Q	2019E 3Q	2019E 4Q	2019E Year	2020E 1Q	2020E 2Q	2020E 3Q	2020E 4Q	2020E Year	2021E Year
Summary Cash Flow Statement											
Discretionary Cash Flow											
Adjusted Net Income including NCI	83	85	(55)	(240)	**(127)**	5	(1)	19	46	**69**	**162**
DD&A	$646	$602	$711	$721	**$2,680**	$605	$591	$572	$566	**$2,334**	**$2,114**
Deferred income taxes	($19)	($23)	($10)	$66	**$14**	($134)	($124)	($111)	($98)	**($466)**	**($374)**
Other Non Cash Charges	$26	$14	($10)	$273	**$303**	$52	$52	$52	$52	**$209**	**$203**
Discretionary Cash Flow from Operations	$736	$678	$636	$820	**$2,870**	$528	$519	$533	$566	**$2,146**	**$2,105**
Changes in working capital	(138)	178	(1)	(42)	**(3)**	0	0	0	0	**0**	**0**
Discontinued Ops	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Net Cash Provided By Operating Activities	$598	$856	$635	$778	**$2,867**	$528	$519	$533	$566	**$2,146**	**$2,105**
CAPEX	($597)	($589)	($590)	($590)	**($2,366)**	($488)	($427)	($419)	($415)	**($1,750)**	**($1,410)**
Free Cash Flow	$1	$267	$45	$188	**$501**	$40	$92	$114	$151	**$396**	**$695**
Discretionary cash flow per share	$1.96	$1.80	$1.69	$2.18	**$7.62**	$1.40	$1.38	$1.41	$1.50	**$5.69**	**$5.58**
Debt adjusted cash flow	$597	$1,216	($159)	$882	**$2,535**	$587	$578	$592	$625	**$2,383**	**$2,343**
EBITDAX	$1,050	$994	$905	$1,093	**$4,042**	$794	$774	$787	$826	**$3,182**	**$3,104**
EBITDA	$981	$899	$849	$508	**$3,237**	$737	$716	$730	$769	**$2,952**	**$2,889**
LTM EBITDAX	$4,828	$4,554	$4,092			$3,786	$3,566	$3,449			
Condensed Balance Sheet											
Cash	$327	$549	$163	$247	**$247**	$193	$391	$410	$467	**$467**	**$786**
Total Assets	$21,751	$21,806	$21,405	$18,107	**$18,107**	$17,936	$17,970	$17,837	$17,742	**$17,742**	**$17,358**
Total Debt	$7,755	$8,157	$8,393	$8,555	**$8,555**	$8,555	$8,755	$8,755	$8,755	**$8,755**	**$8,755**
Total Shareholder Equity	$6,989	$6,551	$6,301	$3,255	**$3,255**	$3,218	$3,175	$3,153	$3,157	**$3,157**	**$3,146**
Net Debt	$7,428	$7,608	$8,230	$8,308	**$8,308**	$8,362	$8,364	$8,345	$8,288	**$8,288**	**$7,969**
Debt-To-Equity	111%	125%	133%	263%	**263%**	266%	276%	278%	277%	**277%**	**278%**
Net Debt-To-Equity	106%	116%	131%	255%	**255%**	260%	263%	265%	263%	**263%**	**253%**
Debt-to-Cash Flow (Annualized)	3.2x	2.4x	3.3x	2.7x	**3.0x**	4.0x	4.2x	4.1x	3.9x	**4.1x**	**4.2x**
Net Debt-to-Cash Flow (Annualized)	3.1x	2.2x	3.2x	2.7x	**2.9x**	4.0x	4.0x	3.9x	3.7x	**3.9x**	**3.8x**
Debt-to-EBITDAX (Annualized)	1.8x	2.1x	2.3x	2.0x	**2.1x**	2.7x	2.8x	2.8x	2.6x	**2.8x**	**2.8x**
Net Debt-to-EBITDAX (Annualized)	1.8x	1.9x	2.3x	1.9x	**2.1x**	2.6x	2.7x	2.6x	2.5x	**2.6x**	**2.6x**
LTM Debt-to-EBITDAX	1.6x	1.8x	2.1x	2.1x	**2.1x**	2.3x	2.5x	2.5x	2.8x	**2.8x**	**2.8x**
LTM Net Debt-to-EBITDAX	1.5x	1.7x	2.0x	2.1x	**2.1x**	2.2x	2.3x	2.4x	2.6x	**2.6x**	**2.6x**

Source: J.P. Morgan estimates

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Figure 4: APA's NAV Summary

Apache Corporation (APA) — NEUTRAL

Net Asset Value Estimate After-Tax

Oil & Gas Properties	Total		NYMEX			JPM Deck		
Proved Developed Reserves as of 12/31/18	**(MMBoe)**	**% Gas**	**($/Boe)**	**($MM)**	**($/Share)**	**($/Boe)**	**($MM)**	**($/Share)**
United States	776	35%	$8.35	$6,484	$17	$8.49	$6,590	$17
Egypt	187	42%	$15.10	$2,829	$8	$15.20	$2,848	$8
North Sea	117	13%	$17.35	$2,024	$5	$17.47	$2,284	$6
Total Proved Developed Properties				**$11,337**	**$30**		**$11,721**	**$31**
Other Assets				**($MM)**	**($/Share)**		**($MM)**	**($/Share)**
Total Other Assets					**$0.00**			**$0.00**
Balance Sheet & Other				**($MM)**	**($/Share)**		**($MM)**	**($/Share)**
Long-Term Debt				$8,555	$23		$8,555	$23
Cash & Equivalents				($247)	($1)		($247)	($1)
Altus Midstream				($409)	($1.08)		($403)	($1)
Total Balance Sheet & Other				**$7,899**	**$21**		**$7,905**	**$21**
Proven Developed Net Asset Value				**$3,438**	**$9**		**$3,816**	**$10.12**

Oil & Gas Properties	Total							
Undeveloped / Unproven Reserves	**(MMBoe)**	**% Gas**	**($/Boe)**	**($MM)**	**($/Share)**	**($/Boe)**	**($MM)**	**($/Share)**
Egypt				$2,234	$5.93		$2,219	$5.89
U.S. Delaware Basin HZ				$429	$1.14		$450	$1.19
U.S. Midland Basin HZ				$1,029	$2.73		$1,108	$2.94
U.S. Central Basin Platform				$0	$0.00		$0	$0.00
U.S. Permian Vertical Program				$0	$0.00		$0	$0.00
North Sea				$608	$1.61		$633	$1.68
Alpine High Over Pressured				$0	$0.00		$0	$0.00
Alpine High Normally Pressured				$0	$0.00		$0	$0.00
Suriname				$2,184	$5.79		$2,184	$5.79
Total Undeveloped / Unproven				**$4,300**	**$17.20**		**$4,411**	**$17.49**
Proved and Undeveloped Net Asset Value				**$7,738**	**$26.3**		**$8,227**	**$28**

Diluted Shares Out. (MM) 377

Last Price	**$24.92**
Price-to-NAV	**90%**
NAV	**$28**
PD NAV-to-NAV	**37%**

Source: J.P. Morgan estimates

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Investment Thesis, Valuation and Risks

Apache Corp *(Neutral; Price Target: $28.00)*

Investment Thesis

We believe the market began discounting the potential for Suriname discovery when the JV transaction for Total was announced. Since that time, APA shares have outperformed the XOP Index by 9%, which suggests that the market has embedded ~$900 MM of value associated with the discovery. Using our HES NAV as a guide, we think the market could give APA credit for $2.2 billion in net value from Suriname or 1.2 BBoe of gross resource potential.

Valuation

Using our NAV methodology, we calculate a net asset value of $30 per share for Apache (APA). From our analysis, we believe a Neutral rating on APA is justified given resource potential associated with Suriname. Our December 2020 price target of $30, which assumes the stock trades at parity with our NAV estimate. In summary, we value proved developed reserves (net of liabilities) at ~$10 per share and undeveloped/unproven reserves at ~$18 per share to arrive at a total proved developed and undeveloped reserve value of $28 per share.

Risks to Rating and Price Target

- Alpine High Wolfcamp wells dial in an oil mix higher than our expectations.
- Exploration catalyst in Suriname might provide resource upside to our expectations.
- All E&P companies face the same general risks, including: commodity price volatility, infrastructure constraints, oilfield service cost inflation upon accelerating activity, and unexpected geologic irregularities. Furthermore, type curves and proved reserve/resource potential remain underpinned by numerous assumptions subject to uncertainty that can change by material amounts.
- Oil price improvement could negatively impact play economics and ultimately corporate level cash flow, which could cause the stock to underperform our expectations.

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Apache Corp: Summary of Financials

Income Statement - Annual	FY18A	FY19A	FY20E	FY21E	FY22E
Revenue	**7,419**	**6,411**	**5,557**	**5,286**	**-**
SG&A	(431)	(406)	(450)	(420)	-
Adj. EBITDAX	**4,865**	**4,042**	**3,182**	**3,104**	**-**
Exploration expense	(503)	(805)	(230)	(216)	-
Adj. EBITDA	**4,362**	**3,237**	**2,952**	**2,889**	**-**
D&A	(2,405)	(2,680)	(2,334)	(2,114)	-
Adj. EBIT	**1,957**	**557**	**617**	**775**	**-**
Net Interest	(478)	(462)	(395)	(397)	-
Adj. PBT	**958**	**(3,008)**	**114**	**270**	**-**
Tax	(672)	(674)	(46)	(108)	-
Minority Interest	(246)	129	(124)	(119)	-
Adj. Net Income	**679**	**2**	**(55)**	**43**	**-**
Reported EPS	0.10	(9.43)	(0.15)	0.11	-
Adj. EPS	**1.77**	**0.01**	**(0.15)**	**0.11**	**-**
CFFO ex WC/share	9.22	7.62	5.69	5.58	-
DPS	**-**	**-**	**-**	**-**	**-**
Shares outstanding	383	377	377	377	-

Sector data	FY18A	FY19A	FY20E	FY21E	FY22E
Average daily oil equivalent production (mboepd)	466	474	473	431	-
Average daily gas equivalent production (mmcfepd)	2,794	2,845	2,835	2,583	-
Average daily oil production (mbblpd)	245	240	240	228	-
Average daily NGL production (mbblpd)	60	71	76	65	-
Average daily gas production (mmcfpd)	965	981	937	830	-
Capital expenditure	(3,771)	(2,366)	(1,750)	(1,410)	-
Total Production (mmboe)	170	173	173	157	-

Balance Sheet & Cash Flow	FY18A	FY19A	FY20E	FY21E	FY22E
Cash and cash equivalents	714	247	467	786	-
Accounts receivable	1,194	1,185	1,185	1,185	-
Inventories	-	-	-	-	-
Other current assets	779	529	529	529	-
Current assets	**2,687**	**1,961**	**2,181**	**2,500**	**-**
PP&E	18,421	14,158	13,574	12,870	-
LT investments	-	-	-	-	-
Other non current assets	474	1,988	1,988	1,988	-
Total assets	**21,582**	**18,107**	**17,742**	**17,358**	**-**
Short term borrowings	-	-	-	-	-
Payables	709	679	679	679	-
Other short term liabilities	1,492	1,176	1,176	1,176	-
Current liabilities	**2,201**	**1,855**	**1,855**	**1,855**	**-**
Long-term debt	8,054	8,555	8,755	8,755	-
Other long term liabilities	2,515	2,677	2,211	1,837	-
Total liabilities	**12,770**	**13,087**	**12,821**	**12,447**	**-**
Shareholders' equity	7,130	3,255	3,157	3,146	-
Minority interests	1,682	1,765	1,765	1,765	-
Total liabilities & equity	**21,582**	**18,107**	**17,742**	**17,358**	**-**
BVPS	**18.69**	**8.64**	**8.37**	**8.34**	**-**
y/y Growth	*(4.0%)*	*(53.8%)*	*(3.1%)*	*(0.4%)*	-
Net debt/(cash)	7,340	8,308	8,288	7,969	-
Cash flow from operating activities	**3,777**	**2,867**	**2,146**	**2,105**	**-**
o/w Depreciation & amortization	2,405	2,680	2,334	2,114	-
o/w Changes in working capital	245	(3)	0	0	-
Cash flow from investing activities	**(3,944)**	**(2,891)**	**(1,750)**	**(1,410)**	**-**
Cash flow from financing activities	**(787)**	**112**	**(176)**	**(376)**	**-**
Net change in cash	**(954)**	**88**	**220**	**319**	**-**
Adj. Free cash flow to firm	**315**	**501**	**396**	**695**	**-**

Income Statement - Quarterly	1Q20E	2Q20E	3Q20E	4Q20E
Revenue	**1,412**	**1,375**	**1,370**	**1,400**
SG&A	(120)	(115)	(110)	(105)
Adj. EBITDAX	**794**	**774**	**787**	**826**
Exploration expense	(58)	(58)	(58)	(58)
Adj. EBITDA	**737**	**716**	**730**	**769**
D&A	(605)	(591)	(572)	(566)
Adj. EBIT	**132**	**125**	**158**	**203**
Net Interest	(97)	(99)	(99)	(99)
PBT	**8**	**(1)**	**32**	**77**
Tax	(3)	1	(13)	(31)
Minority Interest	(32)	(30)	(31)	(31)
Adj. Net Income	**(28)**	**(30)**	**(12)**	**15**
Reported EPS	(0.07)	(0.08)	(0.03)	0.04
Adj. EPS	**(0.07)**	**(0.08)**	**(0.03)**	**0.04**
CFFO ex WC/share	1.40	1.38	1.41	1.50
DPS	**-**	**-**	**-**	**-**
Shares outstanding	377	377	377	377

Sector data	1Q20E	2Q20E	3Q20E	4Q20E
Average daily oil equivalent production (mboepd)	493	481	461	456
Average daily gas equivalent production (mmcfepd)	2,956	2,888	2,764	2,733
Average daily oil production (mbblpd)	244	243	235	238
Average daily NGL production (mbblpd)	83	79	73	70
Average daily gas production (mmcfpd)	995	958	911	885
Capital expenditure	(488)	(427)	(419)	(415)
Total Production (mmboe)	45	44	42	42

Ratio Analysis	FY18A	FY19A	FY20E	FY21E	FY22E
ROE	9.3%	0.0%	(1.7%)	1.4%	-
ROA	3.1%	0.0%	(0.3%)	0.2%	-
ROCE	3.8%	5.1%	3.1%	3.9%	-
Net debt/equity	0.8	1.7	1.7	1.6	-
Net debt/capital	0.5	0.6	0.7	0.7	-
Interest cover (x)	9.1	7.0	7.5	7.3	-
P/E (x)	14.1	4,694.3	NM	219.6	-
EV/EBITDA (x)	4.2	6.0	6.6	6.6	-
EV/Proved Reserves (boe)	-	-	-	-	-
EV/EBITDAX (x)	3.8	4.8	6.1	6.2	-
Dividend yield	-	-	-	-	-
Tax rate	70.1%	(22.4%)	40.0%	40.0%	-
Unit costs per boe					
Lease operating expense	-8.46	-8.36	-8.25	-8.25	-
Taxes other than income	-1.26	-1.20	-1.20	-1.28	-
DD&A	-14.15	-15.48	-13.50	-13.45	-
G&A	-2.54	-2.35	-2.60	-2.67	-
Exploration expense	-	-	-	-	-
Operating margin/boe	10.96	-10.61	4.27	5.62	-
Cash margin/boe	25.11	4.87	17.77	19.07	-
EBITDAX margin	65.6%	63.0%	57.3%	58.7%	-
CFFO ex WC	3,532	2,870	2,146	2,105	-

Source: Company reports and J.P. Morgan estimates.
Note: $ in millions (except per-share data).Fiscal year ends Dec. o/w - out of which

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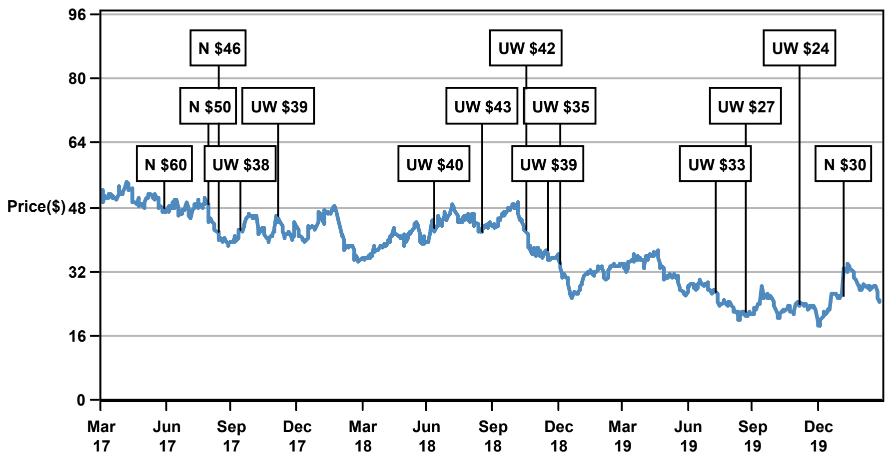
Apache Corp (APA, APA US) Price Chart



Date	Rating	Price ($)	Price Target ($)
31-May-17	N	47.56	60
02-Aug-17	N	48.66	50
15-Aug-17	N	41.57	46
14-Sep-17	UW	42.34	38
07-Nov-17	UW	45.74	39
13-Jun-18	UW	42.76	40
20-Aug-18	UW	42.00	43
19-Oct-18	UW	42.33	42
19-Nov-18	UW	37.43	39
07-Dec-18	UW	33.90	35
12-Jul-19	UW	26.74	33
22-Aug-19	UW	21.73	27
06-Nov-19	UW	23.96	24
07-Jan-20	N	25.64	30

Source: Bloomberg and J.P. Morgan; price data adjusted for stock splits and dividends.
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"Other Disclosures" last revised January 01, 2020.

Exhibit 35

PROCLAMATIONS

Proclamation on Declaring a National Emergency Concerning the Novel Coronavirus Disease (COVID-19) Outbreak

Issued on: **March 13, 2020**

★ ★ ★

In December 2019, a novel (new) coronavirus known as SARS-CoV-2 ("the virus") was first detected in Wuhan, Hubei Province, People's Republic of China, causing outbreaks of the coronavirus disease COVID-19 that has now spread globally. The Secretary of Health and Human Services (HHS) declared a public health emergency on January 31, 2020, under section 319 of the Public Health Service Act (42 U.S.C. 247d), in response to COVID-19. I have taken sweeping action to control the spread of the virus in the United States, including by suspending entry of foreign nationals seeking entry who had been physically present within the prior 14 days in certain jurisdictions where COVID-19 outbreaks have occurred, including the People's Republic of China, the Islamic Republic of Iran, and the Schengen Area of Europe. The Federal Government, along with State and local governments, has taken preventive and proactive measures to slow the spread of the virus and treat those affected, including by instituting Federal quarantines for individuals evacuated from foreign nations, issuing a declaration pursuant to section 319F-3 of the Public Health Service Act (42 U.S.C. 247d-6d), and releasing policies to accelerate the acquisition of personal protective equipment and streamline

bringing new diagnostic capabilities to laboratories. On March 11, 2020, the World Health Organization announced that the COVID-19 outbreak can be characterized as a pandemic, as the rates of infection continue to rise in many locations around the world and across the United States.

The spread of COVID-19 within our Nation's communities threatens to strain our Nation's healthcare systems. As of March 12, 2020, 1,645 people from 47 States have been infected with the virus that causes COVID-19. It is incumbent on hospitals and medical facilities throughout the country to assess their preparedness posture and be prepared to surge capacity and capability. Additional measures, however, are needed to successfully contain and combat the virus in the United States.

NOW, THEREFORE, I, DONALD J. TRUMP, President of the United States, by the authority vested in me by the Constitution and the laws of the United States of America, including sections 201 and 301 of the National Emergencies Act (50 U.S.C. 1601 *et seq*.) and consistent with section 1135 of the Social Security Act (SSA), as amended (42 U.S.C. 1320b-5), do hereby find and proclaim that the COVID-19 outbreak in the United States constitutes a national emergency, beginning March 1, 2020. Pursuant to this declaration, I direct as follows:

Section 1. Emergency Authority. The Secretary of HHS may exercise the authority under section 1135 of the SSA to temporarily waive or modify certain requirements of the Medicare, Medicaid, and State Children's Health Insurance programs and of the Health Insurance Portability and Accountability Act Privacy Rule throughout the duration of the public health emergency declared in response to the COVID-19 outbreak.

Sec. 2. Certification and Notice. In exercising this authority, the Secretary of HHS shall provide certification and advance written notice to the Congress as required by section 1135(d) of the SSA (42 U.S.C. 1320b-5(d)).

Sec. 3. General Provisions. (a) Nothing in this proclamation shall be construed to impair or otherwise affect:

(i) the authority granted by law to an executive department or agency, or the head thereof; or

(ii) the functions of the Director of the Office of Management and Budget relating to budgetary, administrative, or legislative proposals.

(b) This proclamation shall be implemented consistent with applicable law and subject to the availability of appropriations.

(c) This proclamation is not intended to, and does not, create any right or benefit, substantive or procedural, enforceable at law or in equity by any party against the United States, its departments, agencies, or entities, its officers, employees, or agents, or any other person.

IN WITNESS WHEREOF, I have hereunto set my hand this thirteenth day of March, in the year of our Lord two thousand twenty, and of the Independence of the United States of America the two hundred and forty-fourth.

DONALD J. TRUMP

Exhibit 36

The Coronavirus Crisis

Stocks Go Into Shock. Dow Plunges Nearly 3,000 Points

MARCH 16, 2020 · 9:08 AM ET

HEARD ON MORNING EDITION

By Avie Schneider

2-Minute Listen

PLAYLIST Download

Transcript

Markets are falling sharply, even after the Federal Reserve aggressively cut interest rates to near zero.
Johannes Eisele/AFP via Getty Images

Updated at 4:21 p.m. ET

U.S. stock indexes fell sharply Monday, a day after the Federal Reserve aggressively cut interest rates to near zero in a bid to stop the economy from

crashing. The Dow Jones Industrial Average dropped 2,997.20 points, or about 13%, as coronavirus measures rapidly expanded. The S&P 500 index lost nearly 12%.

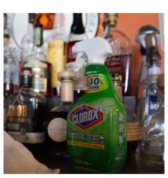
The Dow, which closed at 20,188.52, has lost 31.7% since its record high Feb. 12 as the market plunges deeper into bear territory after an 11-year winning streak.

The Dow's breathtaking drop Monday was the biggest since the Black Monday crash of October 1987, when the blue chip index lost 22%.

The deep stock market sell-off reflects broad concerns that despite these economic measures, the U.S. economy is likely heading toward a recession.

Many parts of the economy have abruptly come to a standstill. On Monday afternoon, most of Bay Area shut down from a directive. San Mateo Mayor Joe Goethals said only police and fire departments, hospitals, grocery stores, pharmacies and a few other businesses will be allowed to remain open.

In the rest of the country, government orders temporarily closed restaurants and bars in New York City, Los Angeles and Chicago and recommendations to ban groups of more than 10 people have been among the latest attempts to stem the spread of the coronavirus.



THE CORONAVIRUS CRISIS

CDC Recommends Against Gatherings Of 50 Or More, As States Close Bars And Restaurants

The hard-hit airline industry is seeking $50 billion in aid and loans from the federal government. "The rapid spread of COVID-19, along with the government and business-imposed restrictions on air travel, are having a unprecedented and debilitating impact on U.S. airlines," the industry group Airlines for America said.

In an afternoon news conference, President Trump said "we're going to back the airlines, 100%."

Leaders of the Group of Seven — the U.S., Canada, France, Germany, Italy, Japan and the United Kingdom — agreed to work together to speed up and coordinate the global response to the pandemic.

"We are mobilizing the full range of instruments, including monetary and fiscal measures, as well as targeted actions, to support immediately and as much as necessary the workers, companies, and sectors most affected," the G-7 said in a statement.

THE CORONAVIRUS CRISIS

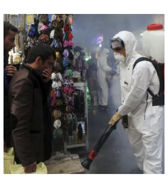
Markets In Europe, Asia Plummet After Central Banks Slash Rates Amid Coronavirus

The S&P 500 index continued to fall after temporary trading halts were lifted on the New York Stock Exchange Friday morning. A 7% drop in the S&P 500 automatically forces trading to stop for 15 minutes, which has happened three times in the past week.

On Sunday evening, the Fed took the extraordinary move of cutting rates by 1 percentage point to near zero. The last time it moved rates that low was in 2008, during the financial crisis.

"The effects of the coronavirus will weigh on economic activity in the near term and pose risks to the economic outlook," the Fed said in a statement.

The drops on Wall Street follow steep falls in Europe, where stock indexes were down as much as 11% Monday.



GOATS AND SODA

Global Deaths From Coronavirus Surpass 6,000

Oil prices fell nearly 9% to about $29 per barrel. They're down more than 50% so far this year.

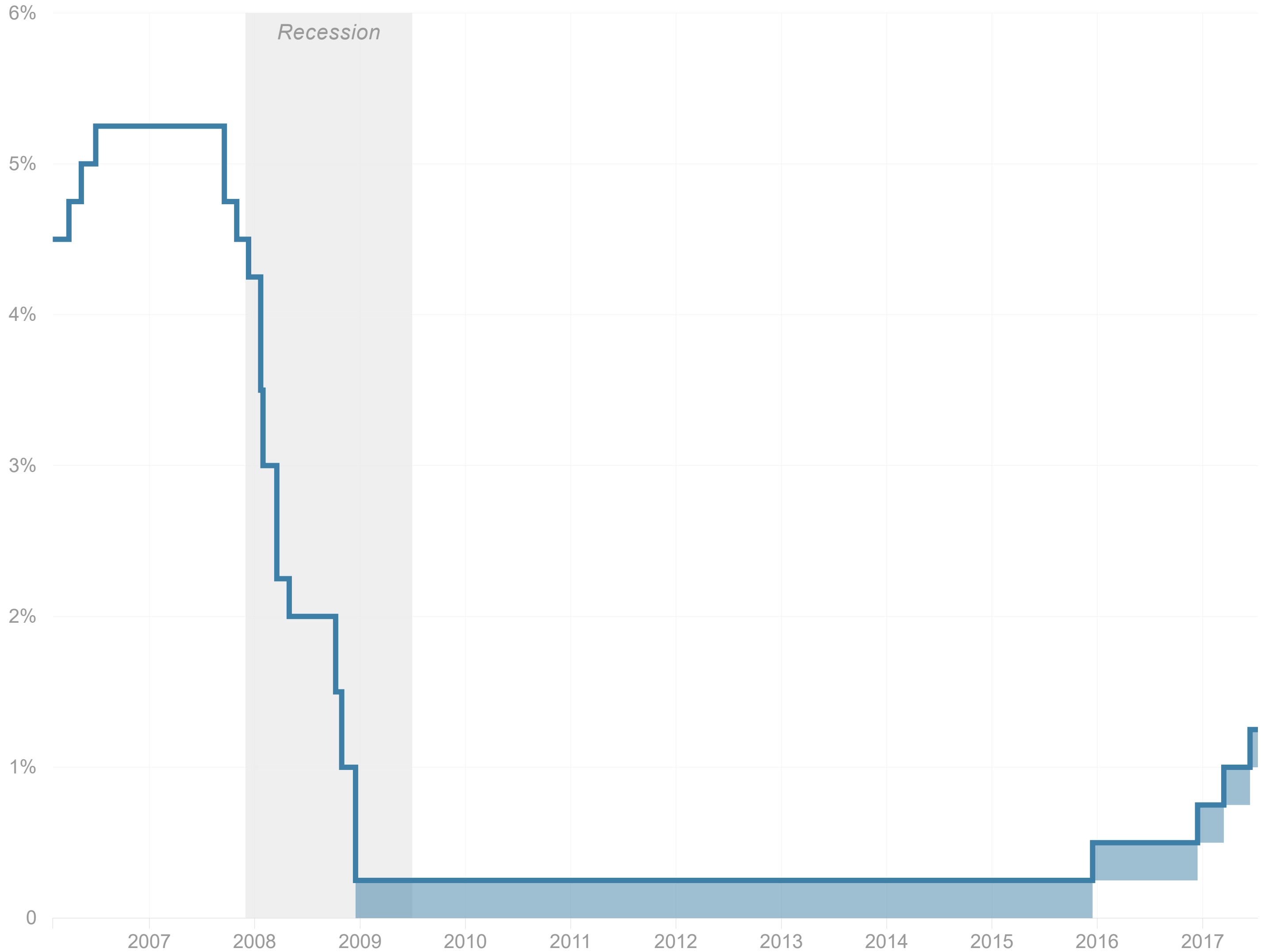
In cutting its key interest rate to near zero, the Fed has not left itself much room to act on rates in the future. It has basically given up a major policy tool

— one that it would need if the economy tumbled into recession.

The Fed also said it will buy $700 billion of Treasurys and other government securities to help grease the financial markets. It took similar steps, known as quantitative easing, during the financial crisis.

The Fed said it's "prepared to use its full range of tools to support the flow of credit to households and businesses."

Fed Cuts Key Interest Rate To Near Zero



Note: Shading for rates indicates target ranges.

Source: Federal Reserve Board

Credit: Connie Hanzhang Jin/NPR

Don't see the graphic above? Click here.

stocks coronavirus stock market dow jones industrial average

Exhibit 37

Seeking Alpha α

Home > Energy Analysis

The Oil Price Crash Puts Apache Corporation In A Tough Spot

Mar. 16, 2020 3:35 AM ET | **APA Corporation (APA)** | 8 Comments | 2 Likes

Sarfaraz A. Khan
8.85K Followers

Summary

- Apache Corp. reported guidance-beating production and an adjusted profit of $0.08/share while generating $66 million of free cash flows in the fourth quarter.
- Oil has tumbled to just $32 a barrel, and the commodity's future outlook is looking uncertain.
- The persistent weakness in natural gas and NGL prices, combined with the drop in oil prices, will push Apache's earnings and cash flows lower in 2020.
- Apache has cut its CapEx guidance for 2020 in order to preserve cash flows, although it will still likely burn cash flows.
- The company has the highest debt-to-equity ratio among large-cap independent E&Ps.

Apache Corp. (NASDAQ:APA) has reported a better-than-expected profit and free cash flows for the fourth quarter, but the company's earnings will likely drop substantially this year as oil plunges to just $33 a barrel. Apache Corp. was already planning to cut capital expenditures this year, and I think it will likely reduce its spending plans further in light of the latest developments. The company doesn't have a strong balance sheet, which, I think, could weigh on the performance of its shares in 2020.

Image courtesy of Pixabay

Earnings Recap

Apache Corporation has recently released strong results for the fourth quarter, in which it reported better-than-expected profit, strong levels of production, and free cash flows.

The company produced 430,461 boe per day in the fourth quarter on an adjusted basis, up 2% from a year earlier and surpassing the high end of its guidance by 5,000 boe per day. The growth was led in large part by the 22% increase in production (particularly NGL volumes) from the Permian Basin in the US. Apache, however, experienced a tough commodity price environment. Although the company posted a 3.1% increase in average realized price for crude oil, the natural gas and NGL prices fell by 20.2% and 34.9% respectively in the same period. Since natural gas and NGL accounted for 53% of the company's total production in Q4-2019, the weakness in their prices pushed its profits lower.

Apache reported an adjusted profit of $118 million, or $0.08 per share, down from $217 million, or $0.31 per share, a year earlier, but considerably better than analysts' consensus estimate of a loss of $0.05 per share. The company also generated strong levels of cash flow from operations of $820 million (ahead of changes in working cap.), which fully covered upstream capital investments of $590 million as well as $70 million of distributions to non-controlling interest and $94 million of dividend payments. From this, we can see that the company ended the period on a strong note with free cash flows of $66 million. (Apache defines FCF as excess cash flow from operations before working capital changes after upstream capital investment, distributions to non-controlling interest and dividend payments.)

Looking Ahead

The oil price environment, however, has gotten significantly worse, with the price of the US benchmark WTI crude dropping from more than $60 a barrel at the start of the year to just $33 a barrel at the time of this writing. The mounting fears related to the spread of coronavirus from China to other parts of the world which triggered a reduction in economic activity pushed prices to the low $50s a barrel range in February. Then, earlier this month, oil prices plunged by double digits, falling to as low as $27.34 per barrel, after Russia shot down OPEC's proposal to cut oil production by an additional 1.5 million bpd which prompted Saudi Arabia, the OPEC's kingpin, to launch an all-out price war.

I think the commodity's short-term outlook is also looking bleak considering Saudi Arabia is reportedly planning to flood the market with additional supplies. Saudi Aramco (ARMCO), the kingdom's flagship oil behemoth which has been producing 9.7 million barrels of oil per day, has been asked by the energy ministry to increase its production capacity to 13 million bpd. Furthermore, the spread of coronavirus also threatens to hurt oil demand. As per some reports, the crude oil demand in China has fallen by 3 million bpd, which is roughly equivalent to a third of the country's total demand. We don't know how the virus will impact oil demand in other key markets, particularly the rest of Asia, Europe, and the US. The demand might improve in the summer months, but I think the commodity's future is currently levered to the trajectory of the coronavirus and OPEC's actions.

The prices of natural gas and NGL have already been low for an extended period. This forced Apache to shift capital away from the wet-gas rich Alpine High play which has been driving the company's production growth. Apache also reduced Alpine High's value by $1.4 billion. The persistently weak natural gas and NGL prices also pushed the company's earnings lower, as evident from the latest quarterly results. The significant drop in oil prices will make things even more difficult for Apache. The WTI oil averaged around $57 a barrel last year, but this could drop to just $38.19 per barrel, as per data from the US Energy Information Administration. The company ended last year with an adjusted profit of $2 million and a cash flow deficit of roughly $177 million. Both of these key metrics, which aren't great to begin with, will likely get even worse in 2020. Barring a major uptick in oil prices, the company will likely report losses and cash flow deficits in the upcoming quarters.

Apache was already planning to significantly cut spending in 2020 and increase its focus on producing oil from high-margin assets in the Permian Basin and international markets (Egypt and the North Sea). I expected the company to further cut its CapEx budget in light of the plunge in oil prices, and that's exactly what it is going to do. Apache initially planned to reduce its upstream capital to the range of $1.6-1.9 billion from $2.37 billion last year, depicting a drop of 26% at the mid-point. But now, it expects to spend between $1 billion and $1.2 billion. The company will continue exploring oil in offshore Suriname, where it holds an interest in 1.4 million acres in Block-58. But it will reduce drilling activity substantially elsewhere, particularly in the US, where it will remove all of the drilling rigs. Apache originally expected to deliver a low- to mid-single digit oil growth rate. It also originally forecast total production of 403,000-422,000 boe per day for 2020, including 270,000-285,000 boe per day from the US and the rest from its international business. The guidance depicts flat levels of total production and US production from 2019. But the company will likely announce a new guidance which will show declining levels of production.

Apache has also slashed quarterly dividends to just to $0.025 per share from $0.25 previously. That's going to translate into cash savings of $340 million on an annualized basis. Although these measures will hurt shareholder returns, I think this is a step in the right direction which indicates that the company's current priority is to preserve its cash flows. The company will do that by cutting its cash outflows considerably in an effort to bring them closer to cash inflows from operations. These measures will soften the blow coming from weak oil, gas, and NGL prices, although Apache might still find it difficult to generate enough cash flow from operations to fully fund its CapEx.

I think what puts Apache in a difficult spot is that its financial health isn't great. It has a weak balance sheet marked by high levels of debt, which limits the company's ability to use additional borrowings to fund a cash flow shortfall. At the end of last year, Apache had $8.16 billion of debt (ex. debt associated with Altus Midstream (ALTM)), which translates into a lofty debt-to-equity ratio of almost 250% - the highest among all large-cap independent oil producers, as per my calculations. If the company uses debt to finance some of its CapEx or dividends, for instance by tapping into its revolving credit facility of $4 billion, then it will put more strain on an already stretched balance sheet.

The good thing, however, is that Apache doesn't have any significant (>$500 million) near-term debt maturities. The company has a total of $937 million of near-term debt which becomes due between 2021 and 2023 (notes of $293 million, $463 million, and $181 million). A vast majority of its total debt matures after 2024. I think the company has ample time to devise a plan to shore up its finances, mainly through the sale of non-core assets.

Shares of Apache have fallen by more than 70% this year following the large drop in oil prices which pushed the entire exploration and production space lower. The company might gain some of the lost ground if it announces a major discovery in offshore Suriname. But in a low oil price environment of $30-40 a barrel, it will swing to quarterly losses and will likely burn cash flows. This, combined with a weak balance sheet, could weigh on the performance of Apache stock. I think in a tough oil price environment, investors should play defense by avoiding highly leveraged companies like Apache.

This article was written by

Sarfaraz A. Khan
8.85K Followers

Hey there, I'm Sarfaraz A. Khan - a seasoned financial writer and investor with a passion for uncovering hidden gems. I have a deep understanding of fundamental analysis and I specialize in writing about mid-cap and small-cap compar

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Comments (8)

Sort by Newest

Exhibit 38

E&P

MULTI-COMPANY UPDATE

SIG SUSQUEHANNA FINANCIAL GROUP, LLLP

Companies mentioned

	Symbol	Price	Rating
Apache Corp.	APA	$8.07	Neutral
Centennial Resource Development	CDEV	$0.56	Neutral
Continental Resources, Inc.	CLR	$9.82	Neutral
Cabot Oil & Gas Corporation	COG	$18.37	Positive
ConocoPhillips	COP	$31.38	Positive
Concho Resources Inc.	CXO	$46.87	Positive
Devon Energy	DVN	$8.70	Positive
EOG Resources, Inc.	EOG	$34.80	Positive
Diamondback Energy, Inc.	FANG	$27.19	Positive
Hess Corporation	HES	$34.92	Positive
Magnolia Oil & Gas Corp.	MGY	$4.98	Positive
Marathon Oil Corp.	MRO	$4.53	Positive
Noble Energy, Inc.	NBL	$7.19	Neutral
Oasis Petroleum, Inc.	OAS	$1.00	Neutral
Occidental Petroleum Corporation	OXY	$14.26	Neutral
Parsley Energy, Inc.	PE	$6.55	Positive
Pioneer Natural Resources Co.	PXD	$70.68	Positive
Range Resources Corporation	RRC	$2.82	Neutral
SM Energy Co.	SM	$2.33	Neutral
Southwestern Energy Co.	SWN	$1.77	Neutral
WPX Energy	WPX	$4.50	Positive
Cimarex Energy Co.	XEC	$18.10	Neutral

Sector Update: Downgrading APA, NBL, OXY to Neutral; Upgrade COG to Positive

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Call to action

With oil markets likely to remain oversupplied, we are changing our 2020/21 WTI price assumptions to $37/$40 (vs. $55/$55 previously). We are also reducing HH natural gas assumptions to ~$2.15/$2.50 (vs. $2.40/$2.60 previously), which is roughly in-line with strip pricing. With the lower price assumptions, we are moving to a Neutral rating on APA, NBL and OXY, while upgrading COG to a Positive rating. The rating changes are primarily governed by our view on balance sheet flexibility.

HIGHLIGHTS

Additionally, we are lowering price targets across the coverage universe, which are now based on a $40/bbl WTI assumption in 2021.

		RATING		PRICE TARGET		PRIOR EPS			CURRENT EPS			
		PRIOR	CURRENT	PRIOR	CURRENT	2019	2020	2021	2019		2020	2021
RATING CHANGES												
APA	$8.07	Positive	Neutral	$35.00	$9.00	-	0.40	0.32	0.26	cy	(0.82)	(0.48)
COG	$18.37	Neutral	Positive	$16.00	$22.00	-	1.15	1.50	1.67	cy	0.71	1.38
NBL	$7.19	Positive	Neutral	$26.00	$8.00	-	0.31	0.89	(0.35)	cy	(0.79)	(0.73)
OXY	$14.26	Positive	Neutral	$50.00	$15.00	-	(0.65)	0.70	1.46	cy	(3.78)	(3.14)
PRICE TARGET CHANGES												
CDEV	$0.56		Neutral	$2.50	$0.60	-	0.14	0.29	0.06	cy	(0.62)	(0.41)
CLR	$9.82		Neutral	$21.00	$10.00	-	1.35	1.90	2.25	cy	(1.17)	(0.52)
COP	$31.38		Positive	$78.00	$42.00	-	2.65	3.09	3.59	cy	(0.70)	0.04
CXO	$46.87		Positive	$103.00	$64.00	-	3.03	4.15	3.05	fy	1.43	0.07
DVN	$8.70		Positive	$34.00	$13.00	-	0.80	1.37	1.39	cy	(0.50)	(0.62)
EOG	$34.80		Positive	$105.00	$55.00	-	4.22	4.72	4.99	cy	0.70	0.37
FANG	$27.19		Positive	$121.00	$40.00	-	7.68	9.49	6.66	fy	3.19	2.46
HES	$34.92		Positive	$82.00	$46.00	-	(0.05)	0.51	(0.90)	cy	(0.58)	(2.65)
MGY	$4.98		Positive	$14.00	$6.00	-	0.18	0.10	0.33	fy	(0.65)	(0.56)
MRO	$4.53		Positive	$17.00	$5.50	-	0.27	0.35	0.76	fy	(0.84)	(0.78)
OAS	$1.00		Neutral	$1.50	$1.00	-	(0.35)	(0.32)	(0.06)	cy	(0.69)	(1.05)
PE	$6.55		Positive	$24.00	$11.00	-	1.57	2.03	1.12	fy	0.67	0.50
PXD	$70.68		Positive	$189.00	$100.00	-	8.72	10.73	8.19	cy	2.63	2.35
RRC	$2.82		Neutral	$3.00	$2.50	-	0.41	0.70	0.39	cy	(0.28)	(0.16)
SM	$2.33		Neutral	$9.00	$2.50	-	(0.36)	(0.08)	(0.47)	cy	(0.80)	(2.25)
WPX	$4.50		Positive	$17.00	$7.00	-	0.61	0.67	0.33	cy	0.14	(0.60)
XEC	$18.10		Neutral	$48.00	$19.00	-	4.20	6.04	4.16	cy	0.38	1.08
ESTIMATE CHANGES												
SWN	$1.77		Neutral		$1.50	-	0.30	0.26	0.61	cy	0.26	0.12

Calendar year = cy

HIGHLIGHTS

Continued from previous page

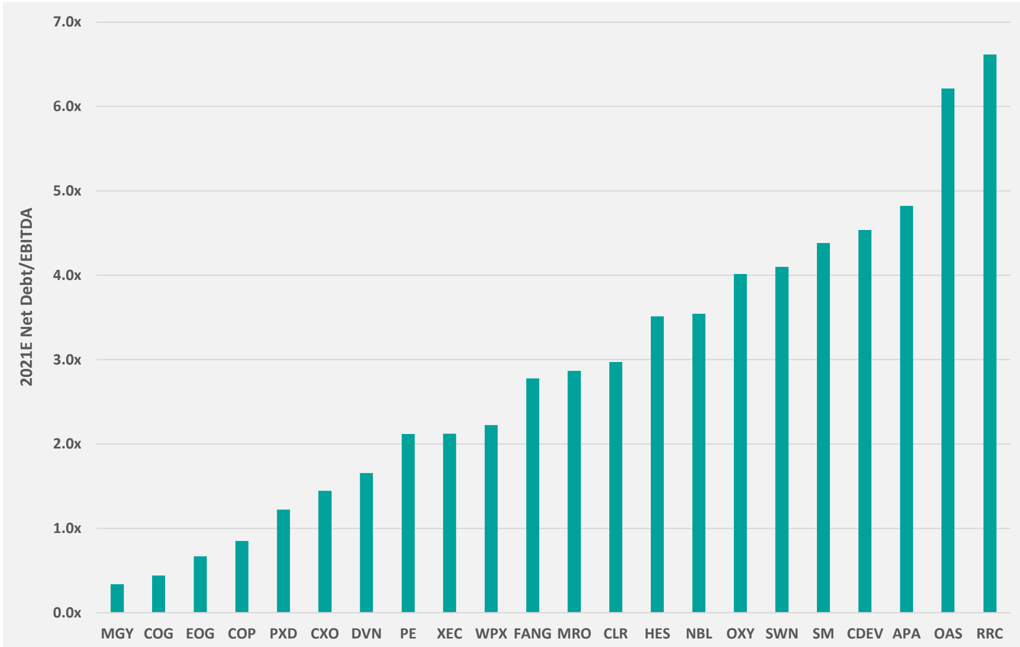
- **Downgrading APA, NBL, OXY to Neutral.** With a large uncertainty in the magnitude and timing of a recovery in oil prices, balance sheet flexibility is a main parameter in our stock selection process with factors such as inventory depth, capital intensity, and valuation still playing an important role in the calculus. Based on this parameter, we are downgrading APA, NBL and OXY to Neutral from Positive. These are three previously Positive-rated names where we now see net leverage exceeding 3.0x by the end of 2021 (see Exhibit 1). While all three companies have already announced activity reduction and APA and OXY have already slashed dividend payments, additional cutbacks may be necessary, dependent on price trajectory. For NBL, we can't rule out a dividend cut, although its dividend obligations are not as onerous as for OXY and APA. While HES also screens as having a high leverage, we note the company will have incremental cash flow and EBITDA starting in early 2022 from the start-up of Phase 2 of the Liza development offshore Guyana for which capex is being incurred currently. Additionally, HES has a significant portion of its oil volumes hedged this year, making it relatively insulated from a further fall in prices this year, although the company is fully exposed to price swings next year.

- **Upgrading COG to Positive.** COG is already seen as a safe haven among E&P names given its strong balance sheet and zero exposure to oil prices. We think COG will be continued to be viewed this way given its free cash flow profile among mid-cap names. Our new price target is $22, which is based on 8x our 2021 DACF estimate at $2.50 HH price assumption. The key risk to our view is natural gas prices could weaken further. Natural gas won't be immune to virus-induced demand weakness, but it's expected to be less severe relative to oil. Additionally, natural gas fundamentals could benefit from reduced associated gas output as oil-directed activities slow.

- **Significant reduction in activities.** Operators are responding to the price shock very quickly. Most companies plan to reduce activities to levels necessary to fund capital expenditures and dividend obligations with operating cash flow. The two names in our coverage that needed to address dividend payments the most (OXY and APA) have already done so. Cash flow declines this year will be somewhat tempered by hedges, but the industry is largely fully exposed to price swings. Assuming $30-35/bbl oil for the remainder of the year, we estimate aggregate capex for our coverage to be down ~27% relative to our previous forecast or a decline of just over 30% compared to 2019 actual expenditures. Looking to 2021, we're modeling capex to decline another 8% or so from this year, which equates to a drop of ~35% relative to forecasts at the beginning of the year.

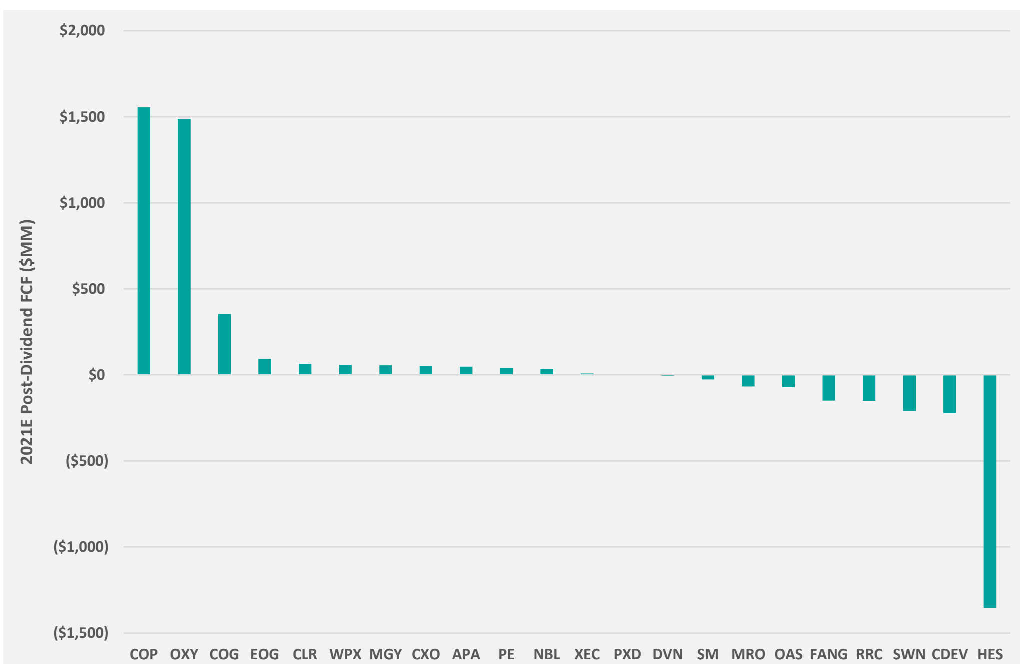
- **We expect domestic production to peak in 2Q, though unlikely to be sufficient to offset the additional OEPC+ barrels.** Although operators are quickly responding to the lower prices, there's still some momentum that'll cause production to peak in the second quarter and should start to show modest decline in the third quarter of this year. For full-year 2021, we expect oil production for our coverage group to decline about 2% compared to this year, and this can be a good proxy for total US oil output. U.S. oil output under the new price scenario could be ~4% and 10% below what it would've been in a mid-$50s oil case this year and 2021, respectively. However, we don't think it's enough to offset the extra barrels potentially coming to the market from OPEC+.

Exhibit 1: 2021E Net Debt/EBITDA for E&P Coverage



Source: Company Filings, SFG Research

Exhibit 2: 2021E Post-Dividend FCF Breakeven for E&P Coverage



Source: Company Filings, SFG Research

Exhibit 3: Valuation for E&P Coverage

	Ticker	Rating	Price Target	Price 03/15/20	Mkt Cap ($MM)	EV/DACF 2019	EV/DACF 2020E	EV/DACF 2021E	Operating FCF Yield (%) 2019	Operating FCF Yield (%) 2020E	Operating FCF Yield (%) 2021E	Net Debt/EBITDA 2019	Net Debt/EBITDA 2020E	Net Debt/EBITDA 2021E
International/Diversified E&Ps:														
Apache Corp	**APA**	Neutral	$9.00	$8.07	$3,042	4.1x	8.8x	7.8x	NA	NA	2.8%	2.4x	5.6x	4.8x
ConocoPhillips	**COP**	Positive	$42.00	$31.38	$32,651	3.3x	6.0x	5.3x	14.5%	5.1%	8.0%	0.5x	1.0x	0.9x
Hess Corp	**HES**	Positive	$46.00	$34.92	$10,649	4.9x	5.2x	8.1x	NA	NA	NA	1.5x	2.1x	3.5x
Noble Energy	**NBL**	Neutral	$8.00	$7.19	$3,437	4.3x	5.1x	5.7x	NA	7.5%	7.7%	2.7x	4.6x	3.5x
						4.1x	**6.3x**	**6.7x**	**14.5%**	**6.3%**	**6.2%**	**1.8x**	**3.3x**	**3.2x**
Permian-pure play E&Ps:														
Centennial Resource Development	**CDEV**	Neutral	$0.60	$0.56	$154	1.9x	4.6x	5.1x	NA	NA	NA	1.6x	4.0x	4.5x
Concho Resources	**CXO**	Positive	$64.00	$46.87	$9,266	4.3x	4.6x	5.2x	NA	2.7%	2.3%	1.3x	1.4x	1.4x
Diamondback Energy	**FANG**	Positive	$40.00	$27.19	$4,328	3.4x	3.8x	4.3x	NA	2.0%	2.1%	2.0x	2.4x	2.8x
Parsley Energy	**PE**	Positive	$11.00	$6.55	$2,460	3.1x	3.5x	3.7x	NA	3.2%	4.6%	1.8x	2.0x	2.1x
Pioneer Natural Resources	**PXD**	Positive	$100.00	$70.68	$11,701	3.8x	5.2x	5.4x	5.1%	2.6%	3.1%	0.8x	1.1x	1.2x
Permian pure-play Average:						**3.3x**	**4.4x**	**4.7x**	**5.1%**	**2.6%**	**3.0%**	**1.5x**	**2.2x**	**2.4x**
Permian-weighted E&Ps:														
Devon Energy	**DVN**	Positive	$13.00	$8.70	$3,292	2.4x	3.4x	3.8x	13.0%	3.5%	4.8%	1.2x	1.5x	1.7x
EOG Resources	**EOG**	Positive	$55.00	$34.80	$20,214	2.1x	3.0x	3.2x	9.2%	3.6%	4.7%	0.4x	0.6x	0.7x
Occidental Petroleum	**OXY**	Neutral	$15.00	$14.26	$12,761	6.4x	7.9x	7.6x	15.6%	13.8%	14.8%	3.5x	4.3x	4.0x
WPX Energy	**WPX**	Positive	$7.00	$4.50	$2,574	3.1x	3.1x	4.0x	0.6%	5.8%	4.5%	1.8x	1.8x	2.2x
Cimarex Energy	**XEC**	Neutral	$19.00	$18.10	$1,844	2.7x	4.1x	4.0x	8.1%	1.9%	5.3%	1.4x	2.2x	2.1x
Permian-weighted Average:						**3.3x**	**4.3x**	**4.5x**	**9.3%**	**5.7%**	**6.8%**	**1.7x**	**2.1x**	**2.1x**
Other-oily E&Ps:														
Continental Resources	**CLR**	Neutral	$10.00	$9.82	$3,644	2.6x	5.3x	4.9x	14.2%	NA	3.8%	1.6x	3.3x	3.0x
SM Energy	**SM**	Neutral	$2.50	$2.33	$263	3.3x	3.2x	4.8x	NA	30.4%	NA	3.0x	2.9x	4.4x
Magnolia Oil & Gas	**MGY**	Positive	$6.00	$4.98	$1,282	2.3x	3.9x	4.5x	19.2%	8.5%	4.4%	0.5x	0.4x	0.3x
Marathon Oil	**MRO**	Positive	$5.50	$4.53	$3,606	2.8x	4.5x	4.6x	6.0%	2.5%	2.5%	1.6x	2.8x	2.9x
Oasis Petroleum	**OAS**	Neutral	$1.00	$1.00	$315	3.1x	4.7x	7.2x	6.2%	4.6%	NA	2.7x	4.1x	6.2x
Other-oily Average:						**2.8x**	**4.3x**	**5.2x**	**11.4%**	**11.5%**	**3.6%**	**1.9x**	**2.7x**	**3.4x**
Gas-weighted E&Ps:														
Cabot Oil & Gas	**COG**	Positive	$22.00	$18.37	$7,285	5.9x	9.4x	6.9x	7.6%	3.2%	7.0%	0.7x	1.0x	0.4x
Range Resources	**RRC**	Neutral	$2.50	$2.82	$695	4.6x	8.0x	7.8x	0.5%	NA	NA	3.9x	6.7x	6.6x
Southwestern Energy	**SWN**	Neutral	$1.50	$1.77	$957	3.7x	4.8x	5.4x	NA	NA	NA	2.7x	3.6x	4.1x
Gas-weighted Average:						**4.7x**	**7.4x**	**6.7x**	**4%**	**3%**	**7%**	**2.4x**	**3.8x**	**3.7x**
Average						**3.5x**	**5.1x**	**5.4x**	**9%**	**6%**	**5%**	**1.8x**	**2.7x**	**2.9x**

Estimates based on WTI/Henry Hub price $56/$2.70 in 2019, $37/$2.15 in 2020 and $40/$2.50 in 2021

For more information on any of the covered companies highlighted within this table, contact your SFG sales representative or visit our disclosure website at https://sig.bluematrix.com/sellside/Disclosures.action.

Source: SFG Research

Exhibit 4: APA Income Statement

Apache Corporation (APA)	2018	1Q '19	2Q '19	3Q '19	4Q '19	2019	1Q '20E	2Q '20E	3Q '20E	4Q '20E	2020E	1Q '21E	2Q '21E	3Q '21E	4Q '21E	2021E
Commodity Prices																
Crude Oil (WTI - $/bbl)	$64.81	$54.72	$59.90	$56.41	$56.94	$56.99	$48.00	$30.00	$35.00	$35.00	$37.00	$40.00	$40.00	$40.00	$40.00	$40.00
Crude Oil (Brent - $/bbl)	$70.94	$59.96	$68.53	$62.01	$62.40	$63.23	$52.00	$33.50	$38.50	$38.50	$40.63	$43.75	$43.75	$43.75	$43.75	$43.75
Nat Gas (Henry Hub - $/MMbtu)	$3.11	$3.17	$2.65	$2.25	$2.50	$2.64	$1.95	$2.00	$2.20	$2.50	$2.16	$2.60	$2.25	$2.50	$2.65	$2.50
Realized Oil - $/bbl	$64.13	$56.84	$62.62	$58.19	$59.66	$59.30	$50.46	$31.61	$36.87	$37.05	$39.20	$42.19	$42.20	$42.11	$42.21	$42.18
Realized NGL - $/bbl	$26.79	$19.33	$14.10	$13.66	$15.78	$15.60	$13.62	$9.20	$10.42	$11.27	$11.19	$11.99	$10.60	$11.22	$11.34	$11.30
Realized Nat Gas - $/MMbtu	$2.57	$2.28	$1.23	$1.49	$1.95	$1.77	$1.00	$1.31	$1.67	$1.91	$1.45	$2.47	$2.18	$2.37	$2.53	$2.39
Daily Production																
Crude - bbl/d	199,039	211,629	197,326	188,787	200,776	199,570	206,815	198,639	182,568	180,512	192,076	175,468	171,596	160,107	164,187	167,787
NGL - bbl/d	59,145	61,365	64,178	74,063	82,799	70,669	82,433	75,712	68,699	62,937	72,409	59,242	55,919	52,791	50,450	54,571
Nat Gas - Mcf/d	819,562	982,317	804,665	771,300	881,318	859,381	845,960	794,979	732,842	690,153	765,686	655,240	629,613	598,765	585,242	616,972
Equivalent - boe/d	394,777	436,714	395,615	391,400	430,461	413,470	430,241	406,848	373,407	358,474	392,099	343,916	332,450	312,692	312,177	325,187
Income Statement *(figures in $000s, except per share)*																
Revenues:																
Oil Sales	5,845,000	1,310,000	1,397,000	1,207,000	1,316,000	5,230,000	1,124,079	688,923	754,098	748,480	3,315,579	810,735	805,625	767,716	784,127	3,168,203
Natural Gas Sales	915,000	236,000	118,000	136,000	188,000	678,000	110,239	128,548	146,668	156,758	542,212	180,622	158,690	165,143	171,518	675,974
NGL Sales	583,000	108,000	83,000	95,000	121,000	407,000	102,956	63,960	66,512	65,953	299,380	64,640	54,620	55,131	53,305	227,695
Other	70,000	8,000	(4,000)	41,000	48,000	93,000	20,000	20,000	20,000	20,000	80,000	20,000	20,000	20,000	20,000	80,000
Total revenues	$7,413,000	1,662,000	1,594,000	1,479,000	1,673,000	$6,408,000	1,357,274	901,430	987,277	991,191	$4,237,171	1,075,997	1,038,935	1,007,991	1,028,949	$4,151,872
Costs & expenses:																
Lease Operating Expenses	1,439,000	$365,000	$389,000	$350,000	$343,000	1,447,000	$380,145	$349,116	$324,550	$319,956	1,373,768	$301,375	$296,490	$280,260	$284,672	1,162,797
Gathering, transmission and processing	343,000	88,000	76,000	66,000	76,000	306,000	82,919	78,067	72,186	68,994	302,166	65,780	64,957	62,418	62,668	255,824
Production taxes	215,000	51,000	46,000	44,000	66,000	207,000	42,648	26,253	29,578	28,037	126,516	31,675	29,306	29,604	29,058	119,643
Exploration	503,000	69,000	95,000	56,000	585,000	805,000	60,000	60,000	60,000	60,000	240,000	60,000	60,000	60,000	60,000	240,000
DD&A	2,405,000	646,000	602,000	711,000	721,000	2,680,000	648,697	620,419	583,201	563,627	2,415,945	530,771	520,763	500,373	499,938	2,051,846
G&A	447,000	127,000	108,000	105,000	116,000	456,000	125,000	95,000	85,000	80,000	385,000	75,000	75,000	75,000	80,000	305,000
Stock-based compensation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ARO	108,000	27,000	26,000	27,000	27,000	107,000	25,000	25,000	25,000	25,000	100,000	25,000	25,000	25,000	25,000	100,000
Impairments	501,000	-	240,000	9,000	2,700,000	2,949,000	-	-	-	-	-	-	-	-	-	-
Other	22,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total operating expense	$5,983,000	$1,373,000	$1,582,000	$1,368,000	$4,634,000	$8,957,000	$1,364,410	$1,253,856	$1,179,515	$1,145,614	$4,943,395	$1,089,601	$1,071,517	$1,032,655	$1,041,337	$4,235,109
Operating Income	$1,430,000	$289,000	$12,000	$111,000	($2,961,000)	($2,549,000)	($7,136)	($352,426)	($192,238)	($154,423)	($706,223)	($13,603)	($32,582)	($24,664)	($12,388)	($83,237)
Other income (expense):																
Gain (loss) on asset sales	23,000	3,000	17,000	-	23,000	43,000	31,450	32,473	32,830	32,830	129,583	45,333	60,536	61,202	61,202	228,273
Net hedges	(17,000)	(30,000)	(8,000)	(2,000)	-	(40,000)	-	-	-	-	-	-	-	-	-	-
Interest expense	(478,000)	(97,000)	(98,000)	(95,000)	(97,000)	(387,000)	(95,818)	(96,058)	(96,400)	(96,489)	(384,765)	(96,481)	(95,559)	(94,728)	(94,753)	(381,522)
Other income (expense)	-	-	(75,000)	-	-	(75,000)	-	-	-	-	-	-	-	-	-	-
Total other expense (income)	(472,000)	(124,000)	(164,000)	(97,000)	(74,000)	(459,000)	(64,368)	(63,585)	(63,570)	(63,659)	(255,182)	(51,148)	(35,022)	(33,527)	(33,552)	(153,249)
Pre-tax income	**$958,000**	**$165,000**	**($152,000)**	**$14,000**	**($3,035,000)**	**($3,008,000)**	**($71,504)**	**($416,010)**	**($255,808)**	**($218,082)**	**($961,405)**	**($64,752)**	**($67,604)**	**($58,191)**	**($45,939)**	**($236,486)**
Income taxes:																
Current	894,000	186,000	187,000	141,000	146,000	660,000	145,880	80,541	98,923	100,665	426,009	112,128	113,412	110,680	113,525	449,745
Deferred	(222,000)	(19,000)	(23,000)	(10,000)	66,000	14,000	(199,508)	(392,549)	(290,779)	(264,227)	(1,147,063)	(160,692)	(164,115)	(154,323)	(147,979)	(627,110)
Total income taxes	$672,000	$167,000	$164,000	$131,000	$212,000	$674,000	($53,628)	($312,008)	($191,856)	($163,562)	($721,054)	($48,564)	($50,703)	($43,643)	($34,455)	($177,365)
tax rate	70.1%	35.0%	35.0%	35.0%	35.0%	-22.4%	35.0%	35.0%	35.0%	35.0%	75.0%	35.0%	35.0%	35.0%	35.0%	75.0%
% deferred	-33.0%	65.0%	65.0%	65.0%	65.0%	2.1%	65.0%	65.0%	65.0%	65.0%	159.1%	65.0%	65.0%	65.0%	65.0%	353.6%
Disc operations, net	(244,000)	(45,000)	(40,000)	(35,000)	287,000	167,000	(17,940)	15,367	5,254	5,274	7,955	(9,384)	(12,462)	(12,656)	(12,607)	(47,109)
Preferred dividends	-	-	(4,000)	(18,000)	(16,000)	(38,000)	(18,347)	(18,668)	(18,995)	(18,995)	(75,005)	(18,995)	(18,995)	(18,995)	(18,995)	(75,980)
Net Income	$42,000	($47,000)	($360,000)	($170,000)	($2,976,000)	($3,553,000)	($54,163)	($107,303)	($77,693)	($68,242)	($307,402)	($44,567)	($48,358)	($46,198)	($43,087)	($182,211)
Special items, net of taxes	637,000	(21,000)	604,000	62,000	3,007,000	3,652,000	-	-	-	-	-	-	-	-	-	-
Net Income after special items	**$679,000**	**($68,000)**	**$244,000**	**($108,000)**	**$31,000**	**$99,000**	**($54,163)**	**($107,303)**	**($77,693)**	**($68,242)**	**($307,402)**	**($44,567)**	**($48,358)**	**($46,198)**	**($43,087)**	**($182,211)**
Reported EPS - Diluted	$0.11	($0.13)	($0.95)	($0.45)	($7.89)	($9.43)	($0.14)	($0.28)	($0.21)	($0.18)	($0.82)	($0.12)	($0.13)	($0.12)	($0.11)	($0.48)
Recurring EPS - Diluted	**$1.77**	**($0.18)**	**$0.65**	**($0.29)**	**$0.08**	**$0.26**	**($0.14)**	**($0.28)**	**($0.21)**	**($0.18)**	**($0.82)**	**($0.12)**	**($0.13)**	**($0.12)**	**($0.11)**	**($0.48)**
Diluted shares outstanding	383,250	376,000	377,000	377,000	377,000	376,750	377,000	377,000	377,000	377,000	377,000	377,000	377,000	377,000	377,000	377,000
Diluted DCFPS	**$9.35**	**$1.96**	**$1.80**	**$1.69**	**$2.18**	**$7.62**	**$1.29**	**$0.47**	**$0.69**	**$0.74**	**$3.19**	**$0.99**	**$0.92**	**$0.89**	**$0.92**	**$3.72**
Margin Analysis ($/boe):																
E&P Revenue	$34.37	$28.94	$33.74	$29.11	$29.36	$30.24	$25.36	$16.26	$19.00	$19.57	$20.14	$22.50	$22.77	$22.63	$23.17	$22.76
Lease Operating Expenses	8.46	8.06	9.39	8.44	7.65	8.37	8.58	8.24	8.18	8.36	8.34	8.36	8.38	8.26	8.41	8.35
GP&T	2.02	1.94	1.84	1.59	1.70	1.77	1.87	1.84	1.82	1.80	1.84	1.83	1.84	1.84	1.85	1.84
Production taxes	1.26	1.13	1.11	1.06	1.47	1.20	0.96	0.62	0.75	0.73	0.77	0.88	0.83	0.87	0.86	0.86
DD&A	14.14	14.27	14.54	17.15	16.09	15.50	14.64	14.64	14.69	14.73	14.67	14.73	14.72	14.75	14.77	14.74
G&A	2.63	2.81	2.61	2.53	2.59	2.64	2.82	2.24	2.14	2.09	2.34	2.08	2.12	2.21	2.36	2.19
Interest	2.81	2.14	2.37	2.29	2.16	2.24	2.16	2.27	2.43	2.52	2.34	2.68	2.70	2.79	2.80	2.74
Cash taxes	5.26	4.11	4.52	3.40	3.26	3.82	3.29	1.90	2.49	2.63	2.59	3.11	3.21	3.26	3.35	3.23
Discretionary cash flow	21.07	16.26	16.37	15.34	18.29	16.59	10.94	4.16	6.59	7.27	7.29	10.40	9.76	9.91	10.20	10.07
E&P EBITDAX	$4,865,000	$1,050,000	$994,000	$905,000	$1,093,000	$4,042,000	$701,561	$327,993	$450,963	$469,204	$1,949,721	$577,168	$548,182	$535,709	$547,551	$2,208,609

Source: SFG Estimates

Exhibit 5: CDEV Income Statement

Centennial Resource Development	2018	1Q '19	2Q '19	3Q '19	4Q '19	2019	1Q '20E	2Q '20E	3Q '20E	4Q '20E	2020E	1Q '21E	2Q '21E	3Q '21E	4Q '21E	2021E
Commodity Prices																
Crude Oil (Spot WTI - $/bbl)	$64.81	$54.72	$59.90	$56.41	$56.94	$56.99	$48.00	$30.00	$35.00	$35.00	$37.00	$40.00	$40.00	$40.00	$40.00	$40.00
Nat Gas (HH Spot - $/MMbtu)	$3.09	$3.17	$2.65	$2.25	$2.50	$2.64	$1.95	$2.00	$2.20	$2.50	$2.16	$2.60	$2.25	$2.50	$2.65	$2.50
Realized Crude Oil - $/bbl	$57.43	$47.93	$54.45	$48.71	$52.16	$50.89	$46.34	$27.24	$32.32	$32.17	$34.76	$37.39	$37.33	$37.27	$37.25	$37.31
Realized Nat Gas - $/MMbtu	$2.02	$1.44	$1.52	$1.26	$1.23	$1.35	$0.81	$0.91	$1.18	$1.34	$1.04	$1.59	$1.16	$1.68	$1.78	$1.55
Daily Production																
Crude - bls/d	34,737	40,511	43,099	42,087	45,022	42,690	43,500	42,300	38,200	35,000	39,733	34,400	34,200	34,300	35,300	34,552
NGL - bls/d	11,868	14,922	14,791	13,413	14,250	14,340	14,500	14,000	12,600	11,500	13,144	11,300	11,200	11,200	11,600	11,325
Nat Gas - Mcf/d	86,868	99,600	109,385	124,902	122,761	114,255	109,800	103,700	93,700	83,300	97,575	81,900	81,400	81,500	84,100	82,229
Equivalent - boe/d	61,084	72,033	76,121	76,317	79,732	76,073	76,300	73,583	66,417	60,383	69,139	59,350	58,967	59,083	60,917	59,582
Income Statement																
Revenues:																
Oil Sales	$709,813	$175,554	$214,305	$200,196	$220,600	$810,655	$183,595	$104,721	$113,562	$103,578	$505,457	$115,754	$116,165	$117,620	$120,986	$470,524
NGL & Natural Gas Sales	$181,232	$39,015	$29,934	$28,934	$35,792	$133,675	$26,095	$21,039	$23,344	$24,430	$94,908	$23,784	$19,989	$24,672	$26,777	$95,222
Total revenues	891,045	$214,569	$244,239	$229,130	$256,392	944,330	$209,690	$125,760	$136,906	$128,008	600,364	$139,538	$136,154	$142,292	$147,762	565,746
Costs & expenses:																
Lease operating	$83,313	$29,862	$34,885	$42,330	$38,899	$145,976	$40,965	$40,177	$36,662	$33,332	$151,136	$31,515	$31,659	$31,527	$32,505	$127,206
Production taxes	$56,523	$16,120	$17,186	$12,213	$17,681	$63,200	$14,678	$8,803	$9,583	$8,961	$42,026	$9,768	$9,531	$9,960	$10,343	$39,602
DD&A	$326,462	$96,558	$112,114	$112,720	$122,851	$444,243	$111,093	$107,137	$97,765	$88,884	$404,880	$80,123	$80,490	$81,535	$84,065	$326,212
Exploration	$21,104	$33,780	$8,279	$9,614	$6,962	$58,635	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
G&A (excl. stk comp)	$44,450	$12,234	$12,359	$10,645	$15,569	$50,807	$13,000	$14,000	$14,000	$17,000	$58,000	$14,000	$14,000	$14,000	$18,000	$60,000
Stock-based compensation	$18,854	$5,884	$6,076	$9,391	$6,998	$28,349	$7,000	$7,000	$7,000	$7,000	$28,000	$7,000	$7,000	$7,000	$7,000	$28,000
Other	$57,624	$15,024	$16,243	$20,853	$20,714	$72,834	$22,219	$21,427	$19,553	$17,777	$80,976	$16,559	$16,634	$16,851	$17,373	$67,417
Total operating expense	$608,330	$209,462	$207,142	$217,766	$229,674	$864,044	$208,955	$198,545	$184,564	$172,953	$765,017	$158,964	$159,314	$160,873	$169,287	$648,437
Operating Income	$282,715	$5,107	$37,097	$11,364	$26,718	$80,286	$735	($72,784)	($47,658)	($44,945)	($164,652)	($19,426)	($23,160)	($18,581)	($21,524)	($82,691)
Other expense (income):																
Interest Expense	($26,358)	($10,160)	($14,437)	($15,246)	($16,148)	($55,991)	($16,463)	($16,461)	($17,122)	($17,495)	($67,542)	($17,644)	($17,767)	($18,271)	($18,808)	($72,489)
Realized derivative gains (loss)	$20,610	($13,353)	$6,388	($8,218)	($3,448)	($18,631)	($153)	$210	($450)	($1,278)	($1,670)	$0	$0	$0	$0	$0
Unealized derivative gains (loss)	($5,274)	$7,482	($4,260)	$9,740	$4,108	$17,070	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Other income (expense)	$483	$124	$142	$40	($829)	($523)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total other expense (income)	(10,539)	(15,907)	(12,167)	(13,684)	(16,317)	(58,075)	(16,616)	(16,251)	(17,572)	(18,773)	(69,212)	(17,644)	(17,767)	(18,271)	(18,808)	(72,489)
Pre-tax income	**$272,176**	**($10,800)**	**$24,930**	**($2,320)**	**$10,401**	**$22,211**	**($15,881)**	**($89,035)**	**($65,230)**	**($63,718)**	**($233,865)**	**($37,070)**	**($40,926)**	**($36,852)**	**($40,332)**	**($155,181)**
Income taxes:																
Current	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deferred	59,440	(2,263)	5,928	1,393	739	5,797	(3,335)	(18,697)	(13,698)	(13,381)	(49,112)	(7,785)	(8,595)	(7,739)	(8,470)	(32,588)
Total income taxes	$59,440	($2,263)	$5,928	$1,393	$739	$5,797	($3,335)	($18,697)	($13,698)	($13,381)	($49,112)	($7,785)	($8,595)	($7,739)	($8,470)	($32,588)
Reported Net Income	$212,736	($8,537)	$19,002	($3,713)	$9,662	$16,414	($12,546)	($70,338)	($51,532)	($50,337)	($184,753)	($29,285)	($32,332)	($29,113)	($31,862)	($122,593)
Less: Net income attributable to noncontrolling	$12,837	($425)	$1,125	($128)	$44	$616	($878)	($4,924)	($3,607)	($3,524)	($12,933)	($2,050)	($2,263)	($2,038)	($2,230)	($8,581)
Net Income after special items	**$199,899**	**($8,112)**	**$17,877**	**($3,585)**	**$9,618**	**$15,798**	**($11,668)**	**($65,414)**	**($47,924)**	**($46,814)**	**($171,820)**	**($27,235)**	**($30,069)**	**($27,075)**	**($29,632)**	**($114,011)**
Special items, net of taxes	14,408	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Reported EPS - Diluted	$0.73	($0.03)	$0.06	($0.01)	$0.03	$0.06	($0.04)	($0.24)	($0.17)	($0.17)	($0.62)	($0.10)	($0.11)	($0.10)	($0.11)	($0.41)
Recurring EPS - Diluted	**$0.79**	**($0.03)**	**$0.06**	**($0.01)**	**$0.03**	**$0.06**	**($0.04)**	**($0.24)**	**($0.17)**	**($0.17)**	**($0.62)**	**($0.10)**	**($0.11)**	**($0.10)**	**($0.11)**	**($0.41)**
Basic shares outstanding	263,341	264,365	264,378	266,205	267,700	265,662	267,700	267,700	267,700	267,700	267,700	267,700	267,700	267,700	267,700	267,700
Diluted shares outstanding	272,305	264,365	276,395	266,205	276,632	270,899	276,632	276,632	276,632	276,632	276,632	276,632	276,632	276,632	276,632	276,632
Discretionary Cashflow (DCF):																
Net Income	$201,470	($8,537)	$19,002	($3,713)	$9,662	$15,182	($12,546)	($70,338)	($51,532)	($50,337)	($158,888)	($29,285)	($32,332)	($29,113)	($31,862)	($105,430)
DD&A	326,462	96,558	112,114	112,720	122,851	444,243	111,093	107,137	97,765	88,884	404,880	80,123	80,490	81,535	84,065	326,212
Exploration & Abandonment	21,104	33,780	8,279	9,614	6,962	58,635	0	0	0	0	0	0	0	0	0	0
Deferred taxes	59,440	(2,263)	5,928	1,393	739	5,797	(3,335)	(18,697)	(13,698)	(13,381)	(49,112)	(7,785)	(8,595)	(7,739)	(8,470)	(32,588)
Stock-based compensation	18,854	5,884	6,076	9,391	6,998	28,349	7,000	7,000	7,000	7,000	28,000	7,000	7,000	7,000	7,000	28,000
Other	(15,484)	4,091	1,847	(13,085)	(3,971)	(11,118)	0	0	0	0	0	0	0	0	0	0
Discretionary cash flow (DCF)	$611,846	$129,513	$153,246	$116,320	$143,241	$541,088	$102,212	$25,102	$39,536	$32,166	$224,881	$50,053	$46,563	$51,683	$50,733	$216,194
Diluted DCFPS	**$2.25**	**$0.49**	**$0.55**	**$0.44**	**$0.52**	**$2.00**	**$0.37**	**$0.09**	**$0.14**	**$0.12**	**$0.81**	**$0.18**	**$0.17**	**$0.19**	**$0.18**	**$0.78**
Margin Analysis ($/boe):																
E&P Revenue	$39.97	$33.10	$35.26	$32.63	$34.95	$34.01	$30.20	$18.78	$22.41	$23.04	$23.73	$26.12	$25.37	$26.18	$26.37	$26.01
Production expense	6.27	7.09	7.52	7.77	7.71	7.53	8.01	7.31	7.57	7.61	7.63	7.73	7.68	7.63	7.65	7.67
DD&A	14.64	14.89	16.19	16.05	16.75	16.00	16.00	16.00	16.00	16.00	16.00	15.00	15.00	15.00	15.00	15.00
G&A	1.99	1.89	1.78	1.52	2.12	1.83	1.87	2.09	2.29	3.06	2.29	2.62	2.61	2.58	3.21	2.76
Interest	1.18	1.57	2.08	2.17	2.20	2.02	2.37	2.46	2.80	3.15	2.67	3.30	3.31	3.36	3.36	3.33
Cash taxes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Discretionary cash flow	27.44	19.98	22.12	16.57	19.53	19.49	14.72	3.75	6.47	5.79	8.89	9.37	8.68	9.51	9.05	9.94
EBITDAX	$669,753	$141,078	$170,087	$132,899	$160,094	$604,158	$118,675	$41,563	$56,658	$49,661	$266,557	$67,697	$64,330	$69,954	$69,541	$271,521

Source: SFG Estimates

Exhibit 6: CLR Income Statement

Continental Resources	2018	1Q '19	2Q '19	3Q '19	4Q '19	2019	1Q '20E	2Q '20E	3Q '20E	4Q '20E	2020E	1Q '21E	2Q '21E	3Q '21E	4Q '21E	2021E
Commodity Prices																
WTI Crude Oil ($/bbl)	$64.81	$54.72	$59.90	$56.41	$56.94	$56.99	$48.00	$30.00	$35.00	$35.00	$37.00	$40.00	$40.00	$40.00	$40.00	$40.00
Henry Hub Nat Gas ($/mmbtu)	$3.11	$3.17	$2.65	$2.25	$2.50	$2.64	$1.95	$2.00	$2.20	$2.50	$2.16	$2.60	$2.25	$2.50	$2.65	$2.50
Realized Oil ($/bbl)	$59.18	$50.05	$54.66	$51.28	$51.33	$51.82	$43.76	$25.48	$30.10	$29.86	$32.44	$35.05	$35.01	$35.00	$34.96	$35.00
Realized Nat Gas ($/mmbtu)	$2.87	$2.73	$1.78	$1.53	$1.87	$1.97	$1.46	$1.36	$1.54	$1.88	$1.55	$2.08	$1.58	$1.88	$2.12	$1.91
Daily Production																
Crude - bls/d	168,177	193,921	193,586	198,074	206,249	197,992	197,813	189,229	186,067	185,451	189,619	178,723	177,766	180,289	180,700	179,377
Nat Gas - mcf/d	780,083	829,891	826,969	805,446	954,556	854,423	965,287	929,412	907,429	864,497	916,489	809,946	780,897	765,912	750,387	776,592
Equivalent - boe/d	298,190	332,236	331,414	332,315	365,342	340,396	358,694	344,131	337,305	329,534	342,367	313,714	307,915	307,941	305,765	308,809
STATEMENT OF OPERATIONS																
(data in thousands, except per share)																
Revenues:																
Oil & natural gas sales	$4,678,722	$1,109,584	$1,137,425	$1,081,400	$1,185,980	$4,514,389	$916,156	$553,828	$643,800	$658,600	$2,772,384	$715,444	$678,343	$712,587	$727,505	$2,833,878
Other	33,155	8,588	6,303	13,378	6,976	35,245	8,000	8,000	8,000	8,000	32,000	8,000	8,000	8,000	8,000	32,000
Total revenues	$4,711,877	$1,118,172	$1,143,728	$1,094,778	$1,192,956	$4,549,634	$924,156	$561,828	$651,800	$666,600	$2,804,384	$723,444	$686,343	$720,587	$735,505	$2,865,878
Costs & expenses:																
Production costs	935,150	242,546	259,689	263,019	263,034	1,028,288	255,116	211,078	217,259	215,452	898,905	208,225	204,434	209,428	209,950	832,036
DD&A	1,859,327	495,019	485,621	484,031	552,711	2,017,382	522,258	501,055	496,513	485,074	2,004,900	451,748	448,325	453,289	450,086	1,803,447
Exploration	7,642	1,837	3,090	2,472	7,268	14,667	3,000	3,000	3,000	3,000	12,000	3,000	3,000	3,000	3,000	12,000
G&A	183,569	47,617	47,226	46,993	53,465	195,301	50,000	50,000	50,000	57,000	207,000	52,000	52,000	52,000	59,000	215,000
Change in production plan liability	125,210	25,316	21,339	20,199	19,348	86,202	0	0	0	0	0	0	0	0	0	0
Other	0	(252)	0	0	0	(252)	0	0	0	0	0	0	0	0	0	0
Total operating expense	$3,110,898	$812,083	$816,965	$816,714	$895,826	$3,341,588	$830,374	$765,133	$766,771	$760,526	$3,122,805	$714,972	$707,759	$717,716	$722,035	$2,862,482
Operating Income	$1,600,979	$306,089	$326,763	$278,064	$297,130	$1,208,046	$93,782	($203,305)	($114,971)	($93,927)	($318,421)	$8,472	($21,416)	$2,871	$13,470	$3,396
Other expense (income):																
Interest Expense	(293,032)	(67,837)	(68,471)	(68,090)	(64,981)	(269,379)	(63,853)	(64,437)	(65,778)	(66,194)	(260,262)	(65,715)	(65,437)	(65,577)	(65,276)	(262,005)
Unrealized hedging loss (gain)	13,009	(14,186)	44,778	(29,289)	(16,915)	(15,612)	0	0	0	0	0	0	0	0	0	0
Realized hedging gain (loss)	(36,939)	13,062	8,670	30,484	12,479	64,695	0	0	0	0	0	0	0	0	0	0
Gain on Asset Sales	16,630	0	(364)	(535)	1,182	283	0	0	0	0	0	0	0	0	0	0
Other expense (income)	(3,845)	1,355	723	(3,465)	516	(871)	0	0	0	0	0	0	0	0	0	0
Total other expense (income)	(304,177)	(67,606)	(14,664)	(70,895)	(67,719)	(220,884)	(63,853)	(64,437)	(65,778)	(66,194)	(260,262)	(65,715)	(65,437)	(65,577)	(65,276)	(262,005)
Pre-tax income	**$1,296,802**	**$238,483**	**$312,099**	**$207,169**	**$229,411**	**$987,162**	**$29,928**	**($267,742)**	**($180,749)**	**($160,120)**	**($578,683)**	**($57,244)**	**($86,853)**	**($62,706)**	**($51,807)**	**($258,609)**
Income taxes	$307,102	$51,990	$75,649	$49,747	$35,303	$212,689	$7,183	($64,258)	($43,380)	($38,429)	($138,884)	($13,166)	($19,976)	($14,422)	($11,916)	($59,480)
Non-controlling Interest	$1,383	$483	$107	$740	($162)	$1,168	$1,500	$1,500	$1,500	$1,500	$6,000	$1,500	$1,500	$1,500	$1,500	$6,000
Reported Net Income	$988,317	$186,976	$236,557	$158,162	$193,946	$775,641	$24,246	($201,984)	($135,869)	($120,192)	($433,799)	($42,578)	($65,377)	($46,784)	($38,391)	($193,129)
Special items, net of taxes	74,455	29,634	(17,421)	41,227	9,643	63,083	-	-	-	-	-	-	-	-	-	-
Net Income after special items	**$1,062,772**	**$216,610**	**$219,136**	**$199,389**	**$203,589**	**$838,724**	**$24,246**	**($201,984)**	**($135,869)**	**($120,192)**	**($433,799)**	**($42,578)**	**($65,377)**	**($46,784)**	**($38,391)**	**($193,129)**
Reported EPS - Diluted	$2.64	$0.50	$0.63	$0.43	$0.53	$2.09	$0.07	($0.54)	($0.37)	($0.32)	($1.17)	($0.11)	($0.18)	($0.13)	($0.10)	($0.52)
Adjusted EPS - Diluted	**$2.84**	**$0.58**	**$0.59**	**$0.54**	**$0.54**	**$2.25**	**$0.07**	**($0.54)**	**($0.37)**	**($0.32)**	**($1.17)**	**($0.11)**	**($0.18)**	**($0.13)**	**($0.10)**	**($0.52)**
Basic shares outstanding	373,793	374,474	374,009	370,676	368,825	371,996	371,074	371,074	371,074	371,074	371,074	371,074	371,074	371,074	371,074	371,074
Diluted shares outstanding	374,459	374,474	374,009	370,676	368,825	371,996	371,074	371,074	371,074	371,074	371,074	371,074	371,074	371,074	371,074	371,074
Discretionary Cashflow (DCF):																
Net Income	$988,317	$186,976	$236,557	$158,162	$193,946	$775,641	$25,746	($200,484)	($134,369)	($118,692)	($427,799)	($41,078)	($63,877)	($45,284)	($36,891)	($187,129)
DD&A	1,859,327	495,019	485,621	484,031	552,711	2,017,382	522,258	501,055	496,513	485,074	2,004,900	451,748	448,325	453,289	450,086	1,803,447
Deferred taxes	307,102	51,990	75,649	49,747	35,303	212,689	7,183	(64,258)	(43,380)	(38,429)	(138,884)	(13,166)	(19,976)	(14,422)	(11,916)	(59,480)
Exploration expense	7,642	1,837	3,090	2,472	7,268	14,667	3,000	3,000	3,000	3,000	12,000	3,000	3,000	3,000	3,000	12,000
Stock-based compensation	47,235	12,107	12,177	12,870	14,890	52,044	13,000	13,000	13,000	16,000	55,000	14,000	14,000	14,000	18,000	60,000
Gain on Sale	(16,630)	0	364	535	(1,182)	(283)	0	0	0	0	0	0	0	0	0	0
Unrealized derivative loss (gain)	(13,009)	14,186	(44,778)	29,289	16,915	15,612	0	0	0	0	0	0	0	0	0	0
Change in production plan liability	125,210	25,316	21,339	20,199	19,348	86,202	0	0	0	0	0	0	0	0	0	0
Other	25,106	2,653	(1,344)	3,514	(3,596)	1,227	0	0	0	0	0	0	0	0	0	0
Discretionary cash flow (DCF)	$3,330,300	$790,084	$788,675	$760,819	$835,603	$3,175,181	$571,187	$252,313	$334,764	$346,954	$1,505,217	$414,504	$381,472	$410,583	$422,279	$1,628,838
Diluted DCFPS	**$8.89**	**$2.11**	**$2.11**	**$2.05**	**$2.27**	**$8.54**	**$1.54**	**$0.68**	**$0.90**	**$0.93**	**$4.06**	**$1.12**	**$1.03**	**$1.11**	**$1.14**	**$4.39**
Margin Analysis ($/boe):																
E&P Revenue	$42.65	$37.55	$38.00	$36.37	$35.66	$36.86	$28.07	$17.69	$20.75	$21.72	$22.12	$25.34	$24.21	$25.15	$25.86	$25.14
Production costs	6.83	6.47	6.84	6.57	6.01	6.46	6.06	4.99	5.24	5.32	5.41	5.58	5.48	5.56	5.62	5.56
DD&A	17.08	16.56	16.10	15.83	16.44	16.24	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00
G&A (ex non-cash comp.)	1.25	1.19	1.16	1.12	1.15	1.15	1.13	1.18	1.19	1.35	1.21	1.35	1.36	1.34	1.46	1.38
Interest	2.69	2.27	2.27	2.23	1.93	2.17	1.96	2.06	2.12	2.18	2.08	2.33	2.34	2.31	2.32	2.32
Cash taxes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Discretionary cash flow	30.60	26.42	26.15	24.89	24.86	25.56	17.50	8.06	10.79	11.44	12.01	14.68	13.61	14.49	15.01	14.45
EBITDAX	$3,623,372	$854,785	$858,019	$828,704	$905,525	$3,447,033	$632,040	$313,750	$397,542	$410,148	$1,753,479	$477,219	$443,909	$473,159	$484,555	$1,878,842

Source: SFG Estimates

Exhibit 7: COG Income Statement

Cabot Oil & Gas	2018	1Q '19	2Q '19	3Q '19	4Q '19	2019	1Q '20E	2Q '20E	3Q '20E	4Q '20E	2020E	1Q '21E	2Q '21E	3Q '21E	4Q '21E	2021E
Commodity Prices																
WTI Crude Oil ($/bbl)	$64.81	$54.72	$59.90	$56.41	$56.94	$56.99	$48.00	$30.00	$35.00	$35.00	$37.00	$40.00	$40.00	$40.00	$40.00	$40.00
HH Nat Gas ($/MMbtu)	$3.11	$3.17	$2.65	$2.25	$2.50	$2.64	$1.95	$2.00	$2.20	$2.50	$2.16	$2.60	$2.25	$2.50	$2.65	$2.50
Realized Crude Oil - $/bbl	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Realized Nat Gas - $/MMbtu	$2.54	$3.35	$2.27	$2.11	$2.15	$2.45	$1.70	$1.71	$1.84	$2.15	$1.85	$2.47	$1.87	$2.13	$2.33	$2.20
Daily Production																
Crude - bls/d	2,066	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nat Gas - Mcf/d	2,000,000	2,275,556	2,349,451	2,398,913	2,457,609	2,370,959	2,376,000	2,301,000	2,482,000	2,467,000	2,406,872	2,476,000	2,419,000	2,460,000	2,478,000	2,458,260
Equivalent - Mcfe/d	2,013,629	2,275,556	2,349,451	2,398,913	2,457,609	2,370,959	2,376,000	2,301,000	2,482,000	2,467,000	2,406,872	2,476,000	2,419,000	2,460,000	2,478,000	2,458,260
Income Statement																
(data in thousands; except per share)																
Revenues:																
Oil & Natural Gas Production	$1,929,872	$633,174	$470,482	$418,133	$463,451	$1,985,240	$366,983	$355,274	$419,057	$490,515	$1,631,829	$550,415	$411,091	$480,930	$531,640	$1,974,076
Brokered Natural gas, net	25,332	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Realized Gains/Losses	(41,630)	52,980	15,397	46,555	23,519	138,451	-	2,996	499	(2,497)	999	-	-	-	-	-
Unrealized Derivative Gains	86,062	(44,723)	48,252	(35,495)	(25,677)	(57,643)	-	-	-	-	-	-	-	-	-	-
Other	4,314	250	(14)	(82)	75	229	-	-	-	-	-	-	-	-	-	-
Total revenues	$2,003,950	$641,681	$534,117	$429,111	$461,368	$2,066,277	$366,983	$358,270	$419,556	$488,018	$1,632,827	$550,415	$411,091	$480,930	$531,640	$1,974,076
Costs & expenses:																
Production costs	$589,019	$161,514	$163,422	$169,469	$174,283	$668,688	$167,627	$160,241	$175,030	$174,638	$677,535	$170,970	$167,696	$172,937	$174,627	$686,229
Exploration	113,820	6,044	4,504	4,481	5,241	20,270	5,000	5,000	5,000	5,000	20,000	5,000	5,000	5,000	5,000	20,000
DD&A	417,479	92,258	96,147	110,889	106,439	405,733	101,622	98,414	107,322	106,673	414,030	102,506	101,259	104,107	104,869	412,742
G&A	63,494	15,958	16,168	16,272	15,692	64,090	16,000	16,000	16,000	17,000	65,000	16,000	16,000	16,000	17,000	65,000
Stock-based compensation	33,147	15,132	6,721	2,119	6,808	30,780	7,000	7,000	7,000	7,000	28,000	7,000	7,000	7,000	7,000	28,000
Other	(25,644)	-	0	(3,896)	0	(3,896)	-	0	0	0	0	-	0	0	0	0
Total operating expense	$1,191,315	$290,906	$286,962	$299,334	$308,463	$1,185,665	$297,249	$286,654	$310,351	$310,311	$1,204,565	$301,476	$296,955	$305,044	$308,496	$1,211,971
Operating Income	$812,635	$350,775	$247,155	$129,777	$152,905	$880,612	$69,735	$71,615	$109,205	$177,707	$428,262	$248,939	$114,136	$175,886	$223,144	$762,105
Other expense (income):																
Interest Expense	73,201	12,181	14,567	13,554	14,650	54,952	16,099	16,099	14,676	14,676	61,551	13,882	13,484	13,484	12,674	53,524
Other expense (income)	41,297	(2,040)	(3,507)	143	(69,160)	(74,564)	0	0	0	0	0	0	0	0	0	0
Total other expense (income)	114,498	10,141	11,060	13,697	(54,510)	(19,612)	16,099	16,099	14,676	14,676	61,551	13,882	13,484	13,484	12,674	53,524
Pre-tax income	**$698,137**	**$340,634**	**$236,095**	**$116,080**	**$207,415**	**$900,224**	**$53,636**	**$55,516**	**$94,529**	**$163,031**	**$366,712**	**$235,057**	**$100,652**	**$162,402**	**$210,470**	**$708,581**
Total income taxes	$141,094	$77,871	$55,086	$25,722	$60,475	$219,154	$12,336	$12,769	$21,742	$37,497	$84,344	$54,063	$23,150	$37,352	$48,408	$162,974
Net Income	$557,043	$262,763	$181,009	$90,358	$146,940	$681,070	$41,300	$42,748	$72,787	$125,534	$282,368	$180,994	$77,502	$125,050	$162,062	$545,607
Special items, net of taxes	(25,930)	44,990	(30,409)	29,304	(26,190)	17,695	-	-	-	-	-	-	-	-	-	-
Adjusted Net Inocme	**$531,113**	**$307,753**	**$150,600**	**$119,662**	**$120,750**	**$698,765**	**$41,300**	**$42,748**	**$72,787**	**$125,534**	**$282,368**	**$180,994**	**$77,502**	**$125,050**	**$162,062**	**$545,607**
Adjusted EPS - Diluted	**$1.19**	**$0.72**	**$0.36**	**$0.29**	**$0.30**	**$1.67**	**$0.10**	**$0.11**	**$0.18**	**$0.32**	**$0.71**	**$0.46**	**$0.20**	**$0.32**	**$0.41**	**$1.38**
Diluted shares outstanding	447,568	425,189	424,349	414,462	405,885	417,471	398,895	398,229	397,562	396,895	397,895	396,562	396,562	396,562	396,562	396,562
Discretionary Cashflow (DCF):																
Net Income	$557,043	$262,763	$181,009	$90,358	$146,940	$681,070	$41,300	$42,748	$72,787	$125,534	$282,368	$180,994	$77,502	$125,050	$162,062	$545,607
DD&A	417,479	92,258	96,147	110,889	106,439	405,733	101,622	98,414	107,322	106,673	414,030	102,506	101,259	104,107	104,869	412,742
Deferred taxes	229,603	88,002	64,645	36,350	55,421	244,418	11,103	11,492	19,567	33,747	75,909	32,438	13,890	18,676	24,204	89,208
Unrealized derivative loss (gain)	(86,062)	44,723	(48,252)	35,495	25,677	57,643	0	0	0	0	0	0	0	0	0	0
Other	150,301	18,121	8,333	2,380	(56,933)	(28,099)	8,375	8,375	8,375	8,375	33,500	8,375	8,375	8,375	8,375	33,500
Discretionary cash flow (DCF)	$1,268,364	$505,867	$301,882	$275,472	$277,544	$1,360,765	$162,399	$161,028	$208,051	$274,329	$805,807	$324,313	$201,026	$256,208	$299,510	$1,081,057
Diluted DCFPS	**$2.83**	**$1.19**	**$0.71**	**$0.66**	**$0.68**	**$3.26**	**$0.41**	**$0.40**	**$0.52**	**$0.69**	**$2.03**	**$0.82**	**$0.51**	**$0.65**	**$0.76**	**$2.73**
Margin Analysis ($/mcfe):																
E&P Revenue	$2.63	$3.09	$2.20	$1.89	$2.05	$2.29	$1.70	$1.70	$1.84	$2.16	$1.85	$2.47	$1.87	$2.13	$2.33	$2.20
Production, gathering, and transport costs	$0.80	0.79	$0.76	$0.77	$0.77	$0.77	0.78	$0.77	$0.77	$0.77	$0.77	0.77	$0.76	$0.76	$0.77	$0.76
DD&A	0.57	0.45	0.45	0.50	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.46	0.46	0.46	0.46	0.46
G&A	0.09	0.08	0.08	0.07	0.07	0.07	0.07	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Interest	0.10	0.06	0.07	0.06	0.06	0.06	0.07	0.08	0.06	0.06	0.07	0.06	0.06	0.06	0.06	0.06
Cash taxes	(0.12)	(0.05)	(0.04)	(0.05)	0.02	(0.03)	0.01	0.01	0.01	0.02	0.01	0.10	0.04	0.08	0.11	0.08
Discretionary cash flow	1.73	2.47	1.41	1.25	1.23	1.57	0.75	0.77	0.91	1.21	0.91	1.46	0.91	1.13	1.31	1.20
EBITDAX	$1,266,671	$513,661	$311,054	$283,623	$300,257	$1,408,595	$183,356	$182,029	$228,527	$296,380	$890,292	$363,445	$227,395	$291,993	$340,013	$1,222,847

Source: SFG Estimates

Exhibit 8: COP Income Statement

ConocoPhillips (COP)	2018	1Q '19	2Q '19	3Q '19	4Q '19	2019	1Q '20E	2Q '20E	3Q '20E	4Q '20E	2020E	1Q '21E	2Q '21E	3Q '21E	4Q '21E	2021E
Commodity Prices																
Crude Oil (WTI - $/bbl)	$64.81	$54.72	$59.90	$56.41	$56.94	$56.99	$48.00	$30.00	$35.00	$35.00	$37.00	$40.00	$40.00	$40.00	$40.00	$40.00
Crude Oil (Brent - $/bbl)	$70.94	$59.96	$68.53	$62.01	$62.40	$63.23	$52.00	$33.50	$38.50	$38.50	$40.63	$43.75	$43.75	$43.75	$43.75	$43.75
Nat Gas (Henry Hub - $/MMbtu)	$3.09	$3.17	$2.65	$2.25	$2.50	$2.64	$1.95	$2.00	$2.20	$2.50	$2.16	$2.60	$2.25	$2.50	$2.65	$2.50
Realized Oil - $/bbl	$63.65	$57.21	$62.91	$57.21	$57.09	$58.58	$48.10	$29.77	$34.85	$34.93	$36.92	$40.34	$40.32	$40.38	$40.43	$40.37
Realized NGL - $/bbl	$28.70	$22.18	$19.43	$14.37	$17.77	$18.39	$14.51	$9.81	$10.41	$12.02	$11.69	$12.45	$11.25	$11.17	$12.10	$11.74
Realized Nat Gas - $/MMbtu	$4.60	$4.41	$3.64	$3.14	$3.36	$3.65	$3.14	$3.23	$3.32	$3.61	$3.32	$3.67	$3.44	$3.54	$3.65	$3.58
Daily Production																
Crude - bbl/d	719,433	778,000	753,000	773,000	759,000	765,718	714,474	709,188	712,909	712,235	712,204	728,733	722,679	729,087	732,639	728,297
NGL - bbl/d	102,534	110,000	118,000	114,000	118,000	115,019	118,926	118,523	119,644	119,942	119,262	122,629	123,199	124,808	126,031	124,178
Nat Gas - Mcf/d	2,735,921	2,840,000	2,768,000	2,871,000	2,741,000	2,804,910	2,502,328	2,395,399	2,396,384	2,395,098	2,422,157	2,419,829	2,398,932	2,417,812	2,424,472	2,415,281
Equivalent - boe/d	1,277,954	1,361,333	1,332,333	1,365,500	1,333,833	1,348,222	1,250,455	1,226,945	1,231,951	1,231,360	1,235,158	1,254,666	1,245,701	1,256,863	1,262,748	1,255,022
Income Statement *(figures in $000s, except per share)*																
Revenues:																
Oil & Gas sales	20,255,017	4,885,449	4,990,277	4,653,172	4,606,169	19,135,067	3,619,883	2,372,842	2,754,718	2,813,120	11,560,563	3,176,485	3,142,131	3,225,373	3,272,234	12,816,224
Net Marketing, Other	2,941,983	777,551	461,723	682,828	446,831	2,368,933	387,490	362,043	369,436	368,855	1,487,824	410,437	411,470	412,509	411,796	1,646,213
Total revenues	$23,197,000	5,663,000	5,452,000	5,336,000	5,053,000	$21,504,000	4,007,373	2,734,885	3,124,154	3,181,976	$13,048,387	3,586,922	3,553,601	3,637,882	3,684,031	$14,462,436
Costs & expenses:																
Production costs	6,261,000	$1,546,000	$1,612,000	$1,568,000	$1,549,000	6,275,000	$1,462,318	$1,391,825	$1,415,054	$1,414,634	5,683,831	$1,401,791	$1,407,239	$1,431,637	$1,436,919	5,677,587
Exploration	369,000	110,000	122,000	360,000	151,000	743,000	25,000	25,000	25,000	25,000	100,000	50,000	50,000	50,000	50,000	200,000
DD&A	5,956,000	1,546,000	1,490,000	1,566,000	1,488,000	6,090,000	1,433,932	1,409,462	1,431,573	1,431,682	5,706,649	1,446,637	1,454,041	1,487,319	1,498,325	5,886,322
G&A	401,000	153,000	129,000	87,000	187,000	556,000	150,000	150,000	150,000	180,000	630,000	150,000	150,000	150,000	180,000	630,000
Impairments	27,000	1,000	1,000	24,000	379,000	405,000	-	-	-	-	-	-	-	-	-	-
Other	353,000	86,000	87,000	86,000	67,000	326,000	80,000	80,000	80,000	80,000	320,000	80,000	80,000	80,000	80,000	320,000
Total operating expense	$13,367,000	$3,442,000	$3,441,000	$3,691,000	$3,821,000	$14,395,000	$3,151,249	$3,056,287	$3,101,627	$3,131,316	$12,440,480	$3,128,428	$3,141,280	$3,198,956	$3,245,245	$12,713,909
Operating Income	$9,830,000	$2,221,000	$2,011,000	$1,645,000	$1,232,000	$7,109,000	$856,123	($321,403)	$22,527	$50,659	$607,907	$458,494	$412,322	$438,926	$438,786	$1,748,528
Other income (expense):																
Interest expense	(735,000)	(233,000)	(165,000)	(184,000)	(196,000)	(778,000)	(170,968)	(170,968)	(170,968)	(170,968)	(683,871)	(170,968)	(170,968)	(170,968)	(168,162)	(681,065)
Other income (expense)	(202,000)	694,000	158,000	226,000	215,000	1,293,000	-	-	-	-	-	-	-	-	-	-
Gain (loss) on asset sales	1,063,000	17,000	82,000	1,785,000	82,000	1,966,000	-	-	-	-	-	-	-	-	-	-
Net hedges	17,000	(12,000)	(28,000)	21,000	(47,000)	(66,000)	-	-	-	-	-	-	-	-	-	-
Total other expense (income)	143,000	466,000	47,000	1,848,000	54,000	2,415,000	(170,968)	(170,968)	(170,968)	(170,968)	(683,871)	(170,968)	(170,968)	(170,968)	(168,162)	(681,065)
Pre-tax income	**$9,973,000**	**$2,687,000**	**$2,058,000**	**$3,493,000**	**$1,286,000**	**$9,524,000**	**$685,155**	**($492,370)**	**($148,440)**	**($120,308)**	**($75,964)**	**$287,526**	**$241,354**	**$267,958**	**$270,624**	**$1,067,462**
Income taxes:																
Current	3,385,000	842,000	681,000	505,000	683,000	2,711,000	231,748	107,166	152,401	159,188	650,502	204,558	193,701	215,575	221,664	835,499
Deferred	283,000	(1,000)	(220,000)	(83,000)	(140,000)	(444,000)	117,198	(92,085)	(32,531)	(22,866)	(30,284)	38,761	28,665	30,736	36,233	134,395
Total income taxes	$3,668,000	$841,000	$461,000	$422,000	$543,000	$2,267,000	$348,946	$15,081	$119,869	$136,322	$620,218	$243,319	$222,367	$246,311	$257,897	$969,894
tax rate	36.8%	35.0%	35.0%	35.0%	35.0%	23.8%	35.0%	35.0%	35.0%	35.0%	-816.5%	35.0%	35.0%	35.0%	35.0%	90.9%
% deferred	7.7%	65.0%	65.0%	65.0%	65.0%	-19.6%	65.0%	65.0%	65.0%	65.0%	-4.9%	65.0%	65.0%	65.0%	65.0%	13.9%
Preferred dividends	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Income	$6,257,000	$1,833,000	$1,580,000	$3,056,000	$720,000	$7,189,000	$321,210	($522,451)	($283,310)	($271,631)	($756,182)	$29,208	$3,987	$6,647	($2,273)	$37,569
Special items, net of taxes	(926,000)	(685,000)	(437,000)	(2,142,000)	111,000	(3,153,000)	-	-	-	-	-	-	-	-	-	-
Net Income after special items	**$5,331,000**	**$1,148,000**	**$1,143,000**	**$914,000**	**$831,000**	**$4,036,000**	**$321,210**	**($522,451)**	**($283,310)**	**($271,631)**	**($756,182)**	**$29,208**	**$3,987**	**$6,647**	**($2,273)**	**$37,569**
Reported EPS - Diluted	$5.33	$1.60	$1.40	$2.75	$0.65	$6.40	$0.30	($0.48)	($0.26)	($0.25)	($0.70)	$0.03	$0.00	$0.01	($0.00)	$0.04
Recurring EPS - Diluted	**$4.54**	**$1.00**	**$1.01**	**$0.82**	**$0.76**	**$3.59**	**$0.30**	**($0.48)**	**($0.26)**	**($0.25)**	**($0.70)**	**$0.03**	**$0.00**	**$0.01**	**($0.00)**	**$0.04**
Diluted shares outstanding	1,174,905	1,146,515	1,131,242	1,113,250	1,099,786	1,122,698	1,086,497	1,080,403	1,073,233	1,066,063	1,076,549	1,059,341	1,053,067	1,046,793	1,040,519	1,049,930
Diluted DCFPS	**$10.47**	**$2.57**	**$3.02**	**$2.38**	**$2.43**	**$10.41**	**$1.90**	**$1.17**	**$1.12**	**$1.35**	**$5.55**	**$1.47**	**$1.70**	**$1.52**	**$1.75**	**$6.43**
Margin Analysis ($/boe):																
E&P Revenue	$51.15	$46.09	$48.40	$43.45	$44.24	$45.52	$37.90	$25.39	$28.99	$29.59	$30.50	$33.37	$32.90	$33.02	$33.29	$33.15
Production costs	18.08	16.75	16.95	16.27	16.37	16.57	16.62	16.12	16.10	16.10	16.24	16.01	15.99	15.93	15.89	15.95
DD&A	15.04	14.59	14.45	14.62	14.29	14.49	15.01	15.08	15.06	15.06	15.05	15.20	15.22	15.23	15.24	15.22
G&A	1.01	1.44	1.25	0.81	1.80	1.32	1.57	1.60	1.58	1.89	1.66	1.58	1.57	1.54	1.83	1.63
Interest	1.86	2.20	1.60	1.72	1.88	1.85	1.79	1.83	1.80	1.80	1.80	1.80	1.79	1.75	1.71	1.76
Cash taxes	8.55	7.94	6.61	4.72	6.56	6.45	2.43	1.15	1.60	1.67	1.72	2.15	2.03	2.21	2.26	2.16
Discretionary cash flow	31.06	27.81	33.19	24.69	25.63	27.80	21.58	13.58	12.67	15.15	15.76	16.35	18.70	16.34	18.49	17.47
E&P EBITDAX	$16,182,000	$3,878,000	$3,624,000	$3,595,000	$3,250,000	$14,347,000	$2,315,055	$1,113,060	$1,479,100	$1,507,341	$6,414,556	$1,955,131	$1,916,363	$1,976,245	$1,987,111	$7,834,850

Source: SFG Estimates

Exhibit 9: CXO Income Statement

Concho Resources	2018	1Q '19	2Q '19	3Q '19	4Q '19	2019	1Q '20E	2Q '20E	3Q '20E	4Q '20E	2020E	1Q '21E	2Q '21E	3Q '21E	4Q '21E	2021E
Commodity Prices																
Crude Oil (Spot WTI - $/bbl)	$64.81	$54.72	$59.90	$56.41	$56.94	$56.99	$48.00	$30.00	$35.00	$35.00	$37.00	$40.00	$40.00	$40.00	$40.00	$40.00
Nat Gas (HH Spot - $/MMbtu)	$3.09	$3.17	$2.65	$2.25	$2.50	$2.64	$1.95	$2.00	$2.20	$2.50	$2.16	$2.60	$2.25	$2.50	$2.65	$2.50
Realized Crude Oil - $/bbl	$52.73	$49.56	$53.15	$52.84	$53.79	$52.35	$55.02	$48.64	$47.66	$46.10	$49.25	$42.80	$42.73	$42.66	$42.65	$42.71
Realized Nat Gas - $/MMbtu	$3.38	$2.59	$1.22	$1.54	$2.12	$1.86	$1.27	$0.99	$1.05	$1.26	$1.14	$1.27	$1.10	$1.35	$1.51	$1.31
Daily Production																
Crude - bls/d	167,811	210,400	205,780	205,870	214,859	209,230	205,800	213,800	218,700	222,300	215,179	226,066	227,817	230,523	231,304	228,946
Nat Gas - Mcf/d	570,756	708,544	737,407	743,598	734,576	731,137	694,500	690,500	706,500	718,000	702,429	730,367	736,024	744,767	747,289	739,672
Equivalent - boe/d	262,937	328,491	328,681	329,803	337,288	331,086	321,550	328,883	336,450	341,967	332,251	347,794	350,488	354,651	355,852	352,225
Income Statement																
Revenues:																
Oil Sales	$3,443,000	$935,000	$1,049,000	$1,023,000	$1,119,000	$4,126,000	$898,560	$563,245	$691,136	$702,512	$2,855,453	$803,664	$818,888	$837,721	$840,558	$3,300,832
Natural Gas Sales	$708,000	$169,000	$78,000	$92,000	$127,000	$466,000	$50,884	$47,383	$66,341	$87,520	$252,127	$77,550	$62,960	$97,622	$108,614	$346,746
Total revenues	4,151,000	$1,104,000	$1,127,000	$1,115,000	$1,246,000	4,592,000	$949,443	$610,628	$757,476	$790,032	3,107,580	$881,215	$881,848	$935,343	$949,172	3,647,578
Costs & expenses:																
Lease operating	$590,000	$174,000	$188,000	$190,000	$164,000	$716,000	$165,325	$161,613	$164,053	$165,170	$656,161	$164,333	$167,445	$171,296	$171,877	$674,951
Production taxes	$305,000	$86,000	$84,000	$85,000	$94,000	$349,000	$75,955	$48,850	$60,598	$63,203	$248,606	$70,497	$70,548	$74,827	$75,934	$291,806
Gathering, Processing & Transportation	$55,000	$26,000	$22,000	$25,000	$42,000	$115,000	$40,965	$41,301	$42,716	$42,472	$167,455	$42,257	$42,101	$43,069	$42,560	$169,986
DD&A	$1,478,000	$465,000	$478,000	$488,000	$533,000	$1,964,000	$519,384	$531,229	$549,423	$558,432	$2,158,467	$532,124	$542,204	$554,674	$556,553	$2,185,556
Accretion	$10,000	$3,000	$2,000	$3,000	$2,000	$10,000	$3,000	$3,000	$3,000	$3,000	$12,000	$3,000	$3,000	$3,000	$3,000	$12,000
Exploration	$65,000	$47,000	$17,000	$26,000	$111,000	$201,000	$15,000	$15,000	$15,000	$15,000	$60,000	$15,000	$15,000	$15,000	$15,000	$60,000
G&A (excl. stk comp)	$229,000	$67,000	$65,000	$55,000	$54,000	$241,000	$55,000	$55,000	$58,000	$62,000	$230,000	$58,000	$60,000	$60,000	$64,000	$242,000
Stock-based compensation	$82,000	$24,000	$23,000	$20,000	$18,000	$85,000	$22,000	$22,000	$22,000	$22,000	$88,000	$22,000	$22,000	$22,000	$22,000	$88,000
Other	$0	$0	$868,000	$101,000	$203,000	$1,172,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total operating expense	$2,814,000	$892,000	$1,747,000	$993,000	$1,221,000	$4,853,000	$896,630	$877,993	$914,790	$931,276	$3,620,689	$907,211	$922,298	$943,867	$950,923	$3,724,299
Operating Income	$1,337,000	$212,000	($620,000)	$122,000	$25,000	($261,000)	$52,814	($267,366)	($157,313)	($141,244)	($513,109)	($25,997)	($40,450)	($8,524)	($1,751)	($76,721)
Other expense (income):																
Interest Expense	($149,000)	($47,000)	($48,000)	($46,000)	($44,000)	($185,000)	($44,713)	($44,733)	($44,733)	($44,713)	($178,890)	($44,713)	($44,713)	($44,713)	($44,713)	($178,850)
Realized hedging gain (loss)	$832,000	$0	($50,000)	($7,000)	($41,000)	($98,000)	$161,465	$398,144	$269,673	$235,724	$1,065,006	$73,117	$77,451	$61,848	$62,486	$274,903
Unrealized heging gain (loss)	$0	($1,059,000)	$267,000	$404,000	($409,000)	($797,000)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Other income (expense)	$869,000	$5,000	$301,000	$307,000	($131,000)	$482,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total other expense (income)	1,552,000	(1,101,000)	470,000	658,000	(625,000)	(598,000)	116,753	353,412	224,940	191,011	886,116	28,405	32,739	17,135	17,774	96,053
Pre-tax income	**$2,889,000**	**($889,000)**	**($150,000)**	**$780,000**	**($600,000)**	**($859,000)**	**$169,567**	**$86,046**	**$67,627**	**$49,767**	**$373,007**	**$2,408**	**($7,711)**	**$8,611**	**$16,023**	**$19,332**
Income taxes:																
Current	(2,000)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deferred	605,000	(194,000)	(53,000)	222,000	(129,000)	(154,000)	40,696	20,651	16,230	11,944	89,522	578	(1,851)	2,067	3,846	4,640
Total income taxes	$603,000	($194,000)	($53,000)	$222,000	($129,000)	($154,000)	$40,696	$20,651	$16,230	$11,944	$89,522	$578	($1,851)	$2,067	$3,846	$4,640
Reported Net Income	$2,286,000	($695,000)	($97,000)	$558,000	($471,000)	($705,000)	$128,871	$65,395	$51,396	$37,823	$283,485	$1,830	($5,860)	$6,545	$12,178	$14,692
Less: Net income attributable to noncontrolling	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Net Income	**$2,286,000**	**($695,000)**	**($97,000)**	**$558,000**	**($471,000)**	**($705,000)**	**$128,871**	**$65,395**	**$51,396**	**$37,823**	**$283,485**	**$1,830**	**($5,860)**	**$6,545**	**$12,178**	**$14,692**
Special items, net of taxes	(1,494,000)	839,000	236,000	(436,000)	677,000	1,316,000	-	-	-	-	-	-	-	-	-	-
Net Income after special items	**$792,000**	**$144,000**	**$139,000**	**$122,000**	**$206,000**	**$611,000**	**$128,871**	**$65,395**	**$51,396**	**$37,823**	**$283,485**	**$1,830**	**($5,860)**	**$6,545**	**$12,178**	**$14,692**
Reported EPS - Diluted	$13.28	($3.49)	($0.49)	$2.78	($2.38)	($3.56)	$0.65	$0.33	$0.26	$0.19	$1.43	$0.01	($0.03)	$0.03	$0.06	$0.07
Recurring EPS - Diluted	**$4.60**	**$0.72**	**$0.69**	**$0.61**	**$1.03**	**$3.05**	**$0.65**	**$0.33**	**$0.26**	**$0.19**	**$1.43**	**$0.01**	**($0.03)**	**$0.03**	**$0.06**	**$0.07**
Basic shares outstanding	171,976	199,148	199,185	199,448	198,121	198,976	197,689	197,689	197,689	197,689	197,689	197,689	197,689	197,689	197,689	197,689
Diluted shares outstanding	172,121	199,148	199,185	199,454	198,121	198,977	197,689	197,689	197,689	197,689	197,689	197,689	197,689	197,689	197,689	197,689
Discretionary Cashflow (DCF):																
Net Income	$2,286,000	($695,000)	($97,000)	$558,000	($471,000)	($705,000)	$128,871	$65,395	$51,396	$37,823	$283,485	$1,830	($5,860)	$6,545	$12,178	$14,692
DD&A	1,478,000	465,000	478,000	488,000	533,000	1,964,000	519,384	531,229	549,423	558,432	2,158,467	532,124	542,204	554,674	556,553	2,185,556
ARO Accretion	10,000	3,000	2,000	3,000	2,000	10,000	3,000	3,000	3,000	3,000	12,000	3,000	3,000	3,000	3,000	12,000
Deferred taxes	605,000	(194,000)	(53,000)	222,000	(129,000)	(154,000)	40,696	20,651	16,230	11,944	89,522	578	(1,851)	2,067	3,846	4,640
Exploration	65,000	47,000	17,000	26,000	111,000	201,000	15,000	15,000	15,000	15,000	60,000	15,000	15,000	15,000	15,000	60,000
Stock-based compensation	82,000	24,000	23,000	20,000	18,000	85,000	22,000	22,000	22,000	22,000	88,000	22,000	22,000	22,000	22,000	88,000
Unrealized hedging loss (gain)	0	1,059,000	(267,000)	(404,000)	409,000	797,000	0	0	0	0	0	0	0	0	0	0
Other	(1,972,000)	(8,000)	565,000	(207,000)	328,000	678,000	0	0	0	0	0	0	0	0	0	0
Discretionary cash flow (DCF)	$2,554,000	$701,000	$668,000	$706,000	$801,000	$2,876,000	$728,950	$657,275	$657,050	$648,199	$2,691,473	$574,532	$574,494	$603,286	$612,576	$2,364,888
Diluted DCFPS	**$14.84**	**$3.52**	**$3.35**	**$3.54**	**$4.04**	**$14.45**	**$3.69**	**$3.32**	**$3.32**	**$3.28**	**$13.61**	**$2.91**	**$2.91**	**$3.05**	**$3.10**	**$11.96**
Margin Analysis ($/boe):																
E&P Revenue	$35.88	$31.63	$35.07	$33.72	$36.06	$34.14	$30.71	$18.82	$22.33	$22.33	$23.48	$25.68	$25.68	$25.68	$25.68	$25.68
Production Expense	9.33	$8.79	$9.09	$9.06	8.31	8.81	8.25	7.03	7.26	7.26	7.44	7.50	7.46	7.54	7.57	7.52
Transportation Expense	0.57	0.88	0.74	0.82	1.35	0.95	1.40	1.38	1.38	1.35	1.38	1.35	1.32	1.32	1.30	1.32
DD&A	15.40	15.73	15.98	16.08	17.18	16.25	17.75	17.75	17.75	17.75	17.75	17.00	17.00	17.00	17.00	17.00
G&A	2.39	2.27	2.17	1.81	1.74	1.99	1.88	1.84	1.87	1.97	1.89	1.85	1.88	1.84	1.95	1.88
Interest	1.55	1.59	1.60	1.52	1.42	1.53	1.53	1.49	1.45	1.42	1.47	1.43	1.40	1.37	1.37	1.39
Cash taxes	(0.02)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Discretionary cash flow	26.61	23.71	22.33	23.27	25.81	23.80	24.91	21.96	21.23	20.60	22.13	18.35	18.01	18.49	18.71	18.39
EBITDAX	$2,742,000	$755,000	$717,000	$757,000	$853,000	$3,082,000	$773,663	$702,008	$701,782	$692,911	$2,870,364	$619,245	$619,206	$647,998	$657,288	$2,543,738

Source: SFG Estimates

Exhibit 10: DVN Income Statement

Devon Energy	2018	1Q '19	2Q '19	3Q '19	4Q '19	2019	1Q '20E	2Q '20E	3Q '20E	4Q '20E	2020E	1Q '21E	2Q '21E	3Q '21E	4Q '21E	2021E
Commodity Prices																
WTI Crude Oil ($/bbl)	$64.81	$54.72	$59.90	$56.41	$56.94	$56.99	$48.00	$30.00	$35.00	$35.00	$37.00	$40.00	$40.00	$40.00	$40.00	$40.00
HH Nat Gas ($/MMbtu)	$3.09	$3.17	$2.65	$2.25	$2.50	$2.64	$1.95	$2.00	$2.20	$2.50	$2.16	$2.60	$2.25	$2.50	$2.65	$2.50
Realized Oil - $/bbl	$41.75	$44.11	$57.09	$54.40	$55.41	$52.20	$47.13	$29.34	$34.08	$34.09	$36.22	$38.79	$38.78	$38.79	$38.77	$38.78
Realized NGL - $/bbl	$24.21	$18.64	$14.79	$12.02	$15.79	$15.25	$13.05	$9.33	$9.33	$10.99	$10.69	$11.35	$10.65	$10.01	$10.98	$10.75
Realized Nat Gas - $/MMbtu	$2.35	$2.51	$1.60	$1.56	$1.71	$1.84	$1.11	$1.17	$1.37	$1.71	$1.33	$1.75	$1.35	$1.71	$1.88	$1.67
Daily Production																
Crude - bbl/d	245,975	254,000	241,000	151,000	160,000	201,104	160,100	156,800	155,300	153,400	156,389	151,800	150,000	150,800	149,100	150,419
NGL - bbl/d	106,041	104,000	112,000	109,000	104,000	107,255	74,450	72,800	72,000	70,550	72,444	68,900	66,900	65,950	64,150	66,461
Nat Gas - Mcf/d	1,074,074	1,024,000	1,002,000	1,005,000	1,042,000	1,018,263	616,100	577,300	570,400	545,400	577,194	522,600	509,600	501,300	489,100	505,546
Equivalent - boe/d	531,029	528,667	520,000	427,500	437,667	478,069	337,233	325,817	322,367	314,850	325,031	307,800	301,833	300,300	294,767	301,137
Income Statement *(figures in $000s, except per share)*																
Revenues:																
Oil & Gas sales	5,677,000	1,419,000	1,051,000	1,020,000	1,035,000	4,525,000	837,177	541,663	620,606	638,388	2,637,834	682,394	656,612	677,720	681,108	2,697,834
Marketing/Mid-stream, net	86,000	32,000	17,000	16,000	5,000	70,000	-	-	-	-	-	10,000	10,000	10,000	10,000	40,000
Total revenues	$5,763,000	1,451,000	1,068,000	1,036,000	1,040,000	$4,595,000	837,177	541,663	620,606	638,388	$2,637,834	692,394	666,612	687,720	691,108	$2,737,834
Costs & expenses:																
Production costs	$2,225,000	$506,000	$371,000	$368,000	$324,000	$1,569,000	$316,154	$259,209	$255,876	$249,830	$1,081,069	$237,094	$235,319	$237,602	$233,812	$943,827
DD&A	1,658,000	459,000	394,000	402,000	382,000	1,637,000	406,619	392,853	392,965	383,802	1,576,240	367,052	363,936	366,066	359,321	1,456,373
G&A	827,000	166,000	121,000	125,000	148,000	560,000	121,900	105,000	93,000	106,000	425,900	103,400	103,400	108,600	112,500	427,900
Other	340,000	9,000	(1,000)	(2,000)	27,000	33,000	-	-	-	-	0	-	-	-	-	0
Total operating expense	$5,050,000	$1,140,000	$885,000	$893,000	$881,000	$3,799,000	$844,673	$757,063	$741,841	$739,632	$3,083,208	$707,546	$702,654	$712,268	$705,632	$2,828,100
Operating Income	$713,000	$311,000	$183,000	$143,000	$159,000	$796,000	($7,496)	($215,400)	($121,235)	($101,243)	($445,374)	($15,152)	($36,043)	($24,547)	($14,524)	($90,266)
Other income (expense):																
Other income (expense):	(119,000)	44,000	(20,000)	(16,000)	0	8,000	0	0	0	0	0	0	0	0	0	0
Net hedges	608,000	(709,000)	140,000	127,000	(116,000)	(558,000)	46,382	158,968	125,659	121,237	452,246	9,198	9,313	9,416	9,367	37,295
Interest expense	(282,000)	(73,000)	(66,000)	(60,000)	(64,000)	(263,000)	(64,806)	(64,806)	(64,806)	(64,806)	(259,226)	(64,806)	(64,806)	(64,806)	(64,806)	(259,226)
Total other expense (income)	207,000	(738,000)	54,000	51,000	(180,000)	(813,000)	(18,424)	94,161	60,853	56,430	193,020	(55,608)	(55,493)	(55,391)	(55,439)	(221,931)
Pre-tax income	**$920,000**	**($427,000)**	**$237,000**	**$194,000**	**($21,000)**	**($17,000)**	**($25,921)**	**($121,238)**	**($60,382)**	**($44,813)**	**($252,354)**	**($70,761)**	**($91,536)**	**($79,938)**	**($69,963)**	**($312,197)**
Income taxes:																
Current	(76,000)	(3,000)	(105,000)	2,000	(6,000)	(112,000)	0	0	0	0	0	0	0	0	0	0
Deferred	232,000	(107,000)	176,000	53,000	(27,000)	95,000	(6,480)	(30,310)	(15,095)	(11,203)	(63,088)	(17,690)	(22,884)	(19,984)	(17,491)	(78,049)
Total income taxes	$156,000	($110,000)	$71,000	$55,000	($33,000)	($17,000)	($6,480)	($30,310)	($15,095)	($11,203)	($63,088)	($17,690)	($22,884)	($19,984)	($17,491)	($78,049)
Equity income from EnLink	127,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income	$3,154,000	($317,000)	$495,000	$109,000	($642,000)	($355,000)	($19,440)	($90,929)	($45,286)	($33,610)	($189,265)	($53,070)	($68,652)	($59,953)	($52,472)	($234,148)
Special items, net of taxes	(2,499,000)	475,000	(315,000)	(6,000)	770,000	924,000	-	-	-	-	-	-	-	-	-	-
Net Income after special items	**$655,000**	**$158,000**	**$180,000**	**$103,000**	**$128,000**	**$569,000**	**($19,440)**	**($90,929)**	**($45,286)**	**($33,610)**	**($189,265)**	**($53,070)**	**($68,652)**	**($59,953)**	**($52,472)**	**($234,148)**
Reported EPS - Diluted	$6.29	($0.73)	$1.19	$0.27	($1.67)	($0.87)	($0.05)	($0.24)	($0.12)	($0.09)	($0.50)	($0.14)	($0.18)	($0.16)	($0.14)	($0.62)
Recurring EPS - Diluted	**$1.31**	**$0.36**	**$0.43**	**$0.26**	**$0.33**	**$1.39**	**($0.05)**	**($0.24)**	**($0.12)**	**($0.09)**	**($0.50)**	**($0.14)**	**($0.18)**	**($0.16)**	**($0.14)**	**($0.62)**
Diluted shares outstanding	501,750	434,000	417,000	399,000	385,000	408,750	381,667	378,333	378,333	378,333	379,167	378,333	378,333	378,333	378,333	378,333
Diluted DCFPS	**$5.29**	**$1.56**	**$1.64**	**$1.46**	**$1.46**	**$6.13**	**$1.09**	**$0.80**	**$0.97**	**$0.99**	**$3.84**	**$0.88**	**$0.81**	**$0.85**	**$0.86**	**$3.41**
Margin Analysis ($/boe):																
E&P Revenue	$29.29	$29.82	$22.21	$25.93	$25.70	$25.93	$27.28	$18.27	$20.93	$22.04	$22.17	$24.63	$23.91	$24.53	$25.12	$24.54
Lease operating costs	5.21	4.62	3.45	3.51	2.98	3.50	4.52	3.76	3.57	3.58	3.86	3.58	3.60	3.62	3.65	3.61
Gathering, processing, and transportation	4.60	4.27	4.18	4.12	3.25	3.77	3.72	3.62	3.58	3.51	3.61	3.24	3.22	3.22	3.17	3.21
Production taxes	1.67	1.74	2.00	1.73	1.81	1.72	2.05	1.36	1.48	1.53	1.61	1.74	1.74	1.76	1.80	1.76
DD&A	8.55	9.65	10.23	10.22	9.49	9.38	13.25	13.25	13.25	13.25	13.25	13.25	13.25	13.25	13.25	13.25
G&A	2.53	2.21	2.36	2.14	2.36	2.15	2.87	2.53	2.02	2.42	2.46	2.45	2.48	2.61	2.77	2.57
Interest	1.45	1.53	1.71	1.53	1.59	1.51	2.11	2.19	2.19	2.24	2.18	2.34	2.36	2.35	2.39	2.36
Cash taxes	(0.39)	(0.06)	(2.73)	0.05	(0.15)	(0.64)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Discretionary cash flow	13.69	14.27	17.70	14.85	13.93	14.36	13.51	10.17	12.33	12.95	12.25	11.97	11.21	11.68	12.05	11.73
EBITDAX	$2,701,000	$640,000	$627,000	$652,000	$657,000	$2,576,000	$479,405	$366,422	$430,389	$439,796	$1,716,012	$396,497	$372,606	$387,534	$391,664	$1,548,302

Source: SFG Estimates

Exhibit 11: EOG Income Statement

EOG Resources	2018	1Q '19	2Q '19	3Q '19	4Q '19	2019	1Q '20E	2Q '20E	3Q '20E	4Q '20E	2020E	1Q '21E	2Q '21E	3Q '21E	4Q '21E	2021E
Commodity Prices																
Benchmark Crude Oil (Spot WTI - $/bbl)	$64.81	$54.72	$59.90	$56.41	$56.94	$56.99	$48.00	$30.00	$35.00	$35.00	$37.00	$40.00	$40.00	$40.00	$40.00	$40.00
Benchmark Nat Gas (HH Spot - $/mmbtu)	$3.11	$3.17	$2.65	$2.25	$2.50	$2.64	$1.95	$2.00	$2.20	$2.50	$2.16	$2.60	$2.25	$2.50	$2.65	$2.50
Realized Crude Oil - $/bbl	$65.21	$56.09	$60.99	$56.66	$57.13	$57.71	$48.23	$30.13	$35.16	$35.16	$37.14	$40.19	$40.19	$40.19	$40.19	$40.18
Realized NGL - $/bbl	$26.60	$20.28	$15.63	$12.67	$16.23	$16.03	$12.34	$9.68	$10.05	$11.47	$10.88	$10.32	$10.75	$10.75	$11.47	$10.83
Realized Nat Gas - $/mmbtu	$2.93	$2.85	$2.18	$2.13	$2.36	$2.37	$1.76	$1.85	$1.97	$2.29	$1.97	$2.36	$2.01	$2.17	$2.40	$2.23
Daily Production																
Crude - bbl/d	399,865	435,900	455,700	464,100	468,900	456,262	477,100	481,000	478,200	476,100	478,095	470,200	469,300	472,700	475,700	471,992
NGL - bbl/d	116,118	119,800	131,100	141,300	144,000	134,136	151,108	152,985	153,234	153,545	152,722	151,987	152,217	153,479	154,602	153,079
Nat Gas - Mcf/d	1,219,211	1,308,000	1,356,000	1,373,000	1,425,000	1,365,841	1,394,400	1,451,300	1,435,700	1,421,000	1,425,615	1,471,500	1,469,400	1,473,300	1,476,500	1,472,690
Equivalent - boe/d	719,185	773,700	812,800	834,233	850,400	818,039	860,608	875,869	870,718	866,478	868,419	867,437	866,417	871,729	876,385	870,520
Income Statement																
(figures in $000s, except per share)																
Revenues:																
Oil and Gas sales	11,946,487	2,754,013	2,985,132	2,853,350	2,988,950	11,581,445	2,487,222	1,697,790	1,949,016	2,001,658	8,135,687	2,155,051	2,133,695	2,193,567	2,247,840	8,730,153
Unrealized hedging gains (losses)	93,266	(41,426)	166,856	(22,516)	(153,868)	(50,954)	-	-	-	-	0	-	-	-	-	0
Realized hedging gains (losses)	(258,906)	20,846	10,444	108,418	91,521	231,229	207,060	542,120	240,298	3,161	992,639	-	-	-	-	0
Other	211,405	55,152	34,283	20,910	36,421	146,766	-	-	-	-	-	-	-	-	-	-
Total revenues	$11,992,252	2,788,585	3,196,715	2,960,162	2,963,024	$11,908,486	2,694,282	2,239,910	2,189,315	2,004,819	$9,128,326	2,155,051	2,133,695	2,193,567	2,247,840	$8,730,153
Costs & expenses:																
Production costs	3,239,008	$817,014	$838,439	$878,895	$870,211	3,404,559	$879,632	$812,789	$831,083	$831,696	3,355,200	$824,811	$829,876	$845,832	$853,457	3,353,976
Exploration, dryhole, & impairment	501,425	36,418	36,291	58,678	36,495	167,882	40,000	40,000	40,000	40,000	160,000	40,000	40,000	40,000	40,000	160,000
DD&A	3,435,408	879,595	957,304	953,597	959,208	3,749,704	1,037,678	1,036,153	1,025,357	1,016,379	4,115,567	995,384	1,005,260	1,022,538	1,028,000	4,051,182
G&A	426,969	106,672	121,780	135,758	125,187	489,397	123,000	123,000	123,000	126,000	495,000	123,000	123,000	123,000	126,000	495,000
Other	0	72,356	112,130	105,275	228,135	517,896	85,000	85,000	85,000	85,000	340,000	75,000	75,000	75,000	75,000	300,000
Total operating expense	$7,602,810	$1,912,055	$2,065,944	$2,132,203	$2,219,236	$8,329,438	$2,165,310	$2,096,942	$2,104,440	$2,099,075	$8,465,767	$2,058,195	$2,073,136	$2,106,370	$2,122,457	$8,360,158
Operating Income	$4,389,442	$876,530	$1,130,771	$827,959	$743,788	$3,579,048	$528,972	$142,968	$84,875	($94,256)	$662,559	$96,856	$60,559	$87,197	$125,383	$369,995
Other expense (income):																
Other expense (income)	96,608	5,612	8,503	9,118	128,115	151,348	0	0	0	0	0	0	0	0	0	0
Interest Expense	(236,079)	(54,906)	(49,908)	(39,620)	(40,695)	(178,123)	(38,703)	(33,828)	(29,140)	(29,140)	(130,810)	(24,015)	(21,604)	(21,604)	(21,453)	(88,676)
Total other expense (income)	(139,471)	(49,294)	(41,405)	(30,502)	87,420	(26,775)	(38,703)	(33,828)	(29,140)	(29,140)	(130,810)	(24,015)	(21,604)	(21,604)	(21,453)	(88,676)
Pre-tax income	**$4,249,971**	**$827,236**	**$1,089,366**	**$797,457**	**$831,208**	**$3,552,274**	**$490,269**	**$109,141**	**$55,735**	**($123,396)**	**$531,749**	**$72,841**	**$38,955**	**$65,593**	**$103,930**	**$281,319**
Income taxes:																
Current	(72,198)	85,486	23,555	(1,947)	71,605	178,699	5,638	1,255	641	(1,419)	6,115	2,513	1,344	2,263	3,586	9,706
Deferred	894,156	106,324	217,970	184,282	123,082	631,658	107,124	23,847	12,178	(26,962)	116,187	14,240	7,616	12,823	20,318	54,998
Total income taxes	$821,958	$191,810	$241,525	$182,335	$194,687	$810,357	$112,762	$25,102	$12,819	($28,381)	$122,302	$16,753	$8,960	$15,086	$23,904	$64,703
Net Income	$3,428,013	$635,426	$847,841	$615,122	$636,521	$2,741,917	$377,507	$84,038	$42,916	($95,015)	$409,447	$56,087	$29,995	$50,507	$80,026	$216,616
Special items, net of taxes	(200,719)	53,916	(85,499)	39,250	150,364	158,031	-	-	-	-	-	-	-	-	-	-
Net Income after special items	**$3,227,294**	**$689,342**	**$762,342**	**$654,372**	**$786,885**	**$2,899,948**	**$377,507**	**$84,038**	**$42,916**	**($95,015)**	**$409,447**	**$56,087**	**$29,995**	**$50,507**	**$80,026**	**$216,616**
Reported EPS - Diluted	$5.91	$1.10	$1.46	$1.06	$1.10	$4.72	$0.65	$0.14	$0.07	($0.16)	$0.70	$0.10	$0.05	$0.09	$0.14	$0.37
Recurring EPS - Diluted	**$5.56**	**$1.19**	**$1.31**	**$1.13**	**$1.35**	**$4.99**	**$0.65**	**$0.14**	**$0.07**	**($0.16)**	**$0.70**	**$0.10**	**$0.05**	**$0.09**	**$0.14**	**$0.37**
Basic shares outstanding	576,541	577,207	577,460	577,839	578,219	577,681	578,219	578,219	578,219	578,219	578,219	578,219	578,219	578,219	578,219	578,219
Diluted shares outstanding	580,493	580,222	580,247	581,271	580,849	580,647	580,849	580,849	580,849	580,849	580,849	580,849	580,849	580,849	580,849	580,849
Discretionary cash flow (DCF)	$8,271,692	$1,914,777	$2,074,718	$2,021,644	$2,111,011	$8,122,150	$1,685,309	$1,307,038	$1,243,451	$1,057,402	$5,293,201	$1,218,712	$1,195,871	$1,238,868	$1,281,345	$4,934,796
Diluted DCFPS	**$14.25**	**$3.30**	**$3.58**	**$3.48**	**$3.63**	**$13.99**	**$2.90**	**$2.25**	**$2.14**	**$1.82**	**$9.11**	**$2.10**	**$2.06**	**$2.13**	**$2.21**	**$8.50**
Margin Analysis ($/boe):																
E&P Revenue	$40.23	$36.71	$37.98	$36.44	$36.62	$36.93	$32.24	$26.41	$25.56	$23.12	$26.81	$25.80	$25.17	$25.46	$25.86	$25.57
Production costs	12.34	11.73	11.34	11.45	11.12	11.40	11.23	10.20	10.37	10.43	10.56	10.57	10.53	10.55	10.59	10.56
DD&A	13.09	12.63	12.94	12.42	12.26	12.56	13.25	13.00	12.80	12.75	12.95	12.75	12.75	12.75	12.75	12.75
G&A	1.03	0.97	1.13	1.06	1.06	1.05	1.09	1.07	1.06	1.10	1.08	1.09	1.08	1.06	1.09	1.08
Interest	0.90	0.79	0.67	0.52	0.52	0.60	0.49	0.42	0.36	0.37	0.41	0.31	0.27	0.27	0.27	0.28
Cash taxes	(0.28)	1.23	0.32	(0.03)	0.92	0.60	0.07	0.02	0.01	(0.02)	0.02	0.03	0.02	0.03	0.04	0.03
Discretionary cash flow	31.51	27.50	28.05	26.34	26.98	27.20	21.52	16.40	15.52	13.26	16.65	15.61	15.17	15.45	15.89	15.53
EBITDAX	$8,155,055	$1,915,773	$2,070,134	$1,977,666	$2,129,646	$8,093,219	$1,729,650	$1,342,121	$1,273,232	$1,085,123	$5,430,126	$1,245,240	$1,218,819	$1,262,735	$1,306,383	$5,033,177

Source: SFG Estimates

Exhibit 12: FANG Income Statement

Diamondback Energy	2018	1Q '19	2Q '19	3Q '19	4Q '19	2019	1Q '20E	2Q '20E	3Q '20E	4Q '20E	2020E	1Q '21E	2Q '21E	3Q '21E	4Q '21E	2021E
Commodity Prices																
Crude Oil (Spot WTI - $/bbl)	$64.81	$54.72	$59.90	$56.41	$56.94	$56.99	$48.00	$30.00	$35.00	$35.00	$37.00	$40.00	$40.00	$40.00	$40.00	$40.00
Nat Gas (HH Spot - $/MMbtu)	$3.11	$3.17	$2.65	$2.25	$2.50	$2.64	$1.95	$2.00	$2.20	$2.50	$2.16	$2.60	$2.25	$2.50	$2.65	$2.50
Realized Crude Oil - $/bbl	$51.21	$46.92	$53.95	$51.84	$54.69	$51.96	$51.19	$39.08	$41.66	$41.82	$43.46	$39.49	$39.49	$39.49	$39.49	$39.49
Realized Nat Gas - $/MMbtu	$1.74	$1.49	$0.04	$0.69	$1.15	$0.86	$0.81	$0.95	$1.20	$1.32	$1.07	$1.35	$1.05	$1.63	$1.70	$1.43
Daily Production																
Crude - bls/d	94,153	179,056	191,231	185,478	194,967	187,721	204,600	203,500	201,300	196,800	201,536	194,400	196,000	196,900	195,150	195,618
NGL - bls/d	20,455	43,422	49,868	54,065	55,196	50,679	52,550	52,300	51,650	50,400	51,721	49,800	50,200	50,450	50,000	50,114
Nat Gas - mcf/d	94,984	240,933	235,593	285,554	306,728	267,433	322,000	320,400	314,850	305,850	315,745	302,200	304,600	306,050	303,350	304,059
Equivalent - boe/d	130,439	262,633	280,364	287,136	301,284	282,972	310,817	309,200	305,425	298,175	305,882	294,567	296,967	298,358	295,708	296,408
Income Statement																
Revenues:																
Oil & gas sales	$2,131,077	$842,000	$1,000,000	$956,000	$1,089,000	$3,887,000	$977,147	$613,414	$723,295	$716,149	$3,030,006	$768,226	$775,590	$811,769	$807,811	$3,163,396
Other	(27,827)	5,000	4,000	(7,000)	(16,000)	(14,000)	-	-	-	-	-	-	-	-	-	-
Total revenues	2,103,250	$847,000	$1,004,000	$949,000	$1,073,000	3,873,000	$977,147	$613,414	$723,295	$716,149	3,030,006	$768,226	$775,590	$811,769	$807,811	3,163,396
Costs & expenses:																
Lease operating	$204,975	$109,000	$127,000	$128,000	$126,000	$490,000	$131,522	$129,431	$129,256	$124,816	$515,025	$119,300	$121,608	$123,520	$122,423	$486,851
Production taxes	$132,661	$55,000	$64,000	$61,000	$68,000	$248,000	$68,400	$42,939	$50,631	$50,130	$212,100	$51,471	$51,965	$54,388	$54,123	$211,948
GP&T	$27,410	$12,000	$17,000	$25,000	$34,000	$88,000	$35,355	$30,951	$28,099	$24,689	$119,094	$22,534	$22,970	$23,332	$23,124	$91,961
DD&A	$623,039	$322,000	$359,000	$365,000	$401,000	$1,447,000	$395,980	$393,921	$393,387	$384,049	$1,567,338	$344,643	$351,312	$356,837	$353,667	$1,406,458
G&A (excl. stk comp)	$32,735	$13,000	$13,000	$15,000	$15,000	$56,000	$20,000	$22,000	$22,000	$25,000	$89,000	$20,000	$22,000	$22,000	$25,000	$89,000
Stock-based compensation	$31,819	$14,000	$9,000	$4,000	$21,000	$48,000	$9,000	$9,000	$9,000	$15,000	$42,000	$9,000	$9,000	$9,000	$15,000	$42,000
ARO	$2,132	$2,000	$3,000	$1,000	$1,000	$7,000	$2,000	$2,000	$2,000	$2,000	$8,000	$2,000	$2,000	$2,000	$2,000	$8,000
Other	$37,691	$1,000	$1,000	$1,000	$791,000	$794,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total operating expense	$1,092,462	$528,000	$593,000	$600,000	$1,457,000	$3,178,000	$662,258	$630,242	$634,373	$625,685	$2,552,558	$568,948	$580,854	$591,077	$595,338	$2,336,217
Operating Income	$1,010,788	$319,000	$411,000	$349,000	($384,000)	$695,000	$314,889	($16,827)	$88,922	$90,465	$477,448	$199,278	$194,736	$220,691	$212,473	$827,178
Other expense (income):																
Interest Expense	(87,276)	(46,000)	(49,000)	(38,000)	(39,000)	(172,000)	(50,422)	(50,867)	(51,079)	(50,863)	(203,231)	(50,793)	(51,385)	(51,185)	(49,014)	(202,377)
Other expense (income)	189,745	(263,000)	96,000	179,000	(173,000)	(161,000)	63,030	186,210	132,666	133,310	515,215	11,555	10,190	1,310	3,380	26,435
Total other expense (income)	102,469	(309,000)	47,000	141,000	(212,000)	(333,000)	12,608	135,342	81,587	82,447	311,985	(39,238)	(41,195)	(49,875)	(45,634)	(175,942)
Pre-tax income	**$1,113,257**	**$10,000**	**$458,000**	**$490,000**	**($596,000)**	**$362,000**	**$327,497**	**$118,515**	**$170,509**	**$172,912**	**$789,433**	**$160,040**	**$153,541**	**$170,816**	**$166,839**	**$651,236**
Income taxes:																
Current	508	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deferred	167,854	(33,000)	102,000	102,000	(124,000)	47,000	75,324	27,258	39,217	39,770	181,570	36,809	35,314	39,288	38,373	149,784
Total income taxes	$168,362	($33,000)	$102,000	$102,000	($124,000)	$47,000	$75,324	$27,258	$39,217	$39,770	$181,570	$36,809	$35,314	$39,288	$38,373	$149,784
tax rate	15.1%	-330.0%	22.3%	20.8%	20.8%	13.0%	23.0%	23.0%	23.0%	23.0%	23.0%	23.0%	23.0%	23.0%	23.0%	23.0%
% deferred	99.7%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Income attributable to noncontrolling interest	(99,223)	33,000	7,000	20,000	(15,000)	45,000	30,513	20,961	24,580	24,839	100,892	26,564	26,884	28,176	28,229	109,854
Reported Net Income	$845,672	$10,000	$349,000	$368,000	($457,000)	$270,000	$221,660	$70,296	$106,712	$108,303	$506,971	$96,667	$91,343	$103,352	$100,237	$391,598
Special items, net of taxes	(212,413)	$219,000	(69,000)	(129,000)	795,000	816,000	-	-	-	-	-	-	-	-	-	-
Net Income after special items	**$633,259**	**$229,000**	**$280,000**	**$239,000**	**$338,000**	**$1,086,000**	**$221,660**	**$70,296**	**$106,712**	**$108,303**	**$506,971**	**$96,667**	**$91,343**	**$103,352**	**$100,237**	**$391,598**
Reported EPS - Diluted	$8.07	$0.06	$2.11	$2.26	($2.85)	$1.65	$1.39	$0.44	$0.67	$0.68	$3.19	$0.61	$0.57	$0.65	$0.63	$2.46
Recurring EPS - Diluted	**$6.04**	**$1.39**	**$1.70**	**$1.47**	**$1.93**	**$6.66**	**$1.39**	**$0.44**	**$0.67**	**$0.68**	**$3.19**	**$0.61**	**$0.57**	**$0.65**	**$0.63**	**$2.46**
Basic shares outstanding	104,579	164,852	164,839	162,543	159,998	163,058	159,002	159,002	159,002	159,002	159,002	159,002	159,002	159,002	159,002	159,002
Diluted shares outstanding	104,781	165,061	165,019	162,780	160,154	163,254	159,158	159,158	159,158	159,158	159,158	159,158	159,158	159,158	159,158	159,158
Discretionary Cashflow (DCF):																
Net Income	$746,449	$43,000	$356,000	$388,000	($502,000)	$285,000	$252,173	$91,257	$131,292	$133,142	$607,863	$123,231	$118,227	$131,528	$128,466	$501,452
DD&A	623,039	322,000	359,000	365,000	401,000	1,447,000	395,980	393,921	393,387	384,049	1,567,338	344,643	351,312	356,837	353,667	1,406,458
ARO	2,132	2,000	3,000	1,000	1,000	7,000	2,000	2,000	2,000	2,000	8,000	2,000	2,000	2,000	2,000	8,000
Deferred taxes	167,854	(33,000)	102,000	102,000	(124,000)	47,000	75,324	27,258	39,217	39,770	181,570	36,809	35,314	39,288	38,373	149,784
Stock-based compensation	31,819	14,000	9,000	4,000	21,000	48,000	9,000	9,000	9,000	15,000	42,000	9,000	9,000	9,000	15,000	42,000
Other	(11,394)	282,000	(84,000)	(277,326)	228,326	149,000	0	0	0	0	0	0	0	0	0	0
Discretionary cash flow (DCF)	$1,559,899	$630,000	$745,000	$582,674	$25,326	$1,983,000	$734,478	$523,436	$574,896	$573,961	$2,406,771	$515,683	$515,853	$538,653	$537,506	$2,107,694
Diluted DCFPS	**$14.89**	**$3.82**	**$4.51**	**$3.58**	**$0.16**	**$12.15**	**$4.61**	**$3.29**	**$3.61**	**$3.61**	**$15.12**	**$3.24**	**$3.24**	**$3.38**	**$3.38**	**$13.24**
Margin Analysis ($/boe):																
E&P Revenue	$42.23	$36.34	$35.20	$36.61	$35.03	$35.77	$36.71	$28.35	$30.39	$30.89	$31.60	$29.34	$29.00	$29.55	$29.74	$29.41
Production expense	7.09	6.94	7.49	7.15	7.00	7.15	7.07	6.13	6.40	6.38	6.49	6.44	6.42	6.48	6.49	6.46
DD&A	13.09	13.62	14.07	13.82	14.47	14.01	14.00	14.00	14.00	14.00	14.00	13.00	13.00	13.00	13.00	13.00
G&A	0.69	0.55	0.51	0.57	0.54	0.54	0.71	0.78	0.78	0.91	0.79	0.75	0.81	0.80	0.92	0.82
Interest	1.83	1.95	1.92	1.44	1.41	1.67	1.78	1.81	1.82	1.85	1.82	1.92	1.90	1.86	1.80	1.87
Cash taxes	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Discretionary cash flow	32.76	26.65	29.20	22.11	29.41	26.86	26.14	18.87	20.82	21.38	21.81	20.02	19.64	20.17	20.31	20.04
EBITDAX	$1,668,117	$675,000	$789,000	$732,000	$869,000	$3,065,000	$782,900	$572,303	$623,975	$622,824	$2,602,002	$564,476	$565,237	$587,838	$584,520	$2,302,071

Source: SFG Estimates

Exhibit 13: HES Income Statement

Hess Corporation (HES)	2018	1Q '19	2Q '19	3Q '19	4Q '19	2019	1Q '20E	2Q '20E	3Q '20E	4Q '20E	2020E	1Q '21E	2Q '21E	3Q '21E	4Q '21E	2021E
Commodity Prices																
Crude Oil (WTI - $/bbl)	$64.81	$54.72	$59.90	$56.41	$56.94	$56.99	$48.00	$30.00	$35.00	$35.00	$37.00	$40.00	$40.00	$40.00	$40.00	$40.00
Crude Oil (Brent - $/bbl)	$70.94	$59.96	$68.53	$62.01	$62.40	$63.23	$52.00	$33.50	$38.50	$38.50	$40.63	$43.75	$43.75	$43.75	$43.75	$43.75
Nat Gas (Henry Hub - $/MMbtu)	$3.11	$3.17	$2.65	$2.25	$2.50	$2.64	$1.95	$2.00	$2.20	$2.50	$2.16	$2.60	$2.25	$2.50	$2.65	$2.50
Realized Oil - $/bbl	$61.20	$56.66	$60.19	$55.99	$55.01	$56.88	$47.34	$30.12	$34.99	$35.01	$36.66	$39.93	$39.94	$39.93	$39.94	$39.94
Realized NGL - $/bbl	$21.81	$18.46	$12.18	$9.55	$13.81	$13.22	$12.08	$9.14	$9.06	$9.77	$10.08	$11.78	$10.49	$9.85	$10.49	$10.66
Realized Nat Gas - $/MMbtu	$4.21	$4.36	$3.81	$3.82	$3.48	$3.85	$2.85	$2.87	$3.25	$3.75	$3.18	$3.84	$3.23	$3.59	$4.06	$3.68
Daily Production																
Crude - bbl/d	146,101	164,000	161,000	165,000	183,000	168,293	176,296	187,863	195,936	191,279	187,875	190,291	187,503	182,774	182,964	185,854
NGL - bbl/d	38,504	40,000	43,000	52,000	52,000	46,797	49,793	50,671	35,139	52,389	46,980	49,011	48,145	47,036	46,819	47,745
Nat Gas - Mcf/d	552,512	572,000	535,000	563,000	616,000	571,597	604,953	581,771	549,167	591,946	581,897	582,752	575,024	562,500	560,965	570,229
Equivalent - boe/d	276,691	299,333	293,167	310,833	337,667	310,357	326,914	335,496	322,602	342,326	331,838	336,427	331,486	323,559	323,278	328,637
Income Statement *(figures in $000s, except per share)*																
Revenues:																
Oil & Gas sales	4,419,705	1,127,039	1,114,765	1,093,237	1,189,267	4,524,307	971,174	709,114	824,331	867,586	3,372,205	937,387	896,359	899,706	927,003	3,660,455
Net Marketing	70,295	10,962	47,235	54,763	29,733	142,693	25,000	25,000	25,000	25,000	100,000	25,000	25,000	25,000	25,000	100,000
Other	55,000	20,000	7,000	17,000	7,000	51,000	10,000	10,000	10,000	10,000	40,000	10,000	10,000	10,000	10,000	40,000
Total revenues	$4,545,000	1,158,000	1,169,000	1,165,000	1,226,000	$4,718,000	1,006,174	744,114	859,331	902,586	$3,512,205	972,387	931,359	934,706	962,003	$3,800,455
Costs & expenses:																
Operating costs and expenses	922,000	213,000	231,000	251,000	276,000	971,000	257,124	267,889	261,388	275,867	1,062,268	257,301	256,247	252,607	252,201	1,018,356
Production taxes	171,000	39,000	46,000	47,000	52,000	184,000	43,974	28,117	32,883	34,026	139,000	37,272	36,104	35,339	36,081	144,797
Exploration	359,000	34,000	43,000	40,000	106,000	223,000	50,000	55,000	55,000	55,000	215,000	50,000	50,000	50,000	50,000	200,000
DD&A	1,732,000	464,000	459,000	507,000	547,000	1,977,000	525,911	529,494	512,234	545,932	2,113,572	523,209	520,830	513,191	512,839	2,070,069
G&A	114,900	14,700	27,900	33,500	44,000	120,100	30,000	30,000	30,000	35,000	125,000	30,000	30,000	30,000	35,000	125,000
Stock-based compensation	71,100	27,300	20,100	17,500	19,000	83,900	19,500	19,500	19,500	24,500	83,000	19,500	19,500	19,500	24,500	83,000
Impairments	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other	648,000	162,000	165,000	182,000	213,000	722,000	228,404	235,457	207,782	236,645	908,287	218,598	217,008	215,306	213,283	864,196
Total operating expense	$4,018,000	$954,000	$992,000	$1,078,000	$1,257,000	$4,281,000	$1,154,913	$1,165,457	$1,118,787	$1,206,970	$4,646,127	$1,135,880	$1,129,690	$1,115,944	$1,123,905	$4,505,418
E&P Pre-tax Income	$527,000	$204,000	$177,000	$87,000	($31,000)	$437,000	($148,739)	($421,343)	($259,456)	($304,385)	($1,133,922)	($163,493)	($198,331)	($181,237)	($161,902)	($704,963)
Midstream Pre-tax Income	$325,000	$80,000	$75,000	$85,000	$102,000	$342,000	$96,591	$101,698	$81,658	$102,558	$382,505	$92,267	$91,096	$89,842	$88,351	$361,556
Total Pre-tax Income	**$852,000**	**$284,000**	**$252,000**	**$172,000**	**$71,000**	**$779,000**	**($52,147)**	**($319,645)**	**($177,798)**	**($201,826)**	**($751,417)**	**($71,226)**	**($107,235)**	**($91,396)**	**($73,551)**	**($343,407)**
Other Corproate income (expense):																
Interest expense	(339,000)	(83,000)	(80,000)	(77,000)	(77,000)	(317,000)	(77,717)	(77,717)	(77,717)	(77,717)	(310,869)	(77,717)	(77,717)	(77,809)	(78,511)	(311,754)
Other income (expense)	46,000	7,000	8,000	4,000	4,000	23,000	5,000	5,000	5,000	5,000	20,000	5,000	5,000	5,000	5,000	20,000
Corprate G&A	-	(39,000)	(36,000)	(30,000)	(32,000)	(137,000)	(30,000)	(30,000)	(30,000)	(30,000)	(120,000)	(30,000)	(30,000)	(30,000)	(30,000)	(120,000)
Net hedges	-	-	-	-	-	-	97,370	343,980	278,760	278,760	998,870	-	-	-	-	-
Total other expense (income)	(293,000)	(115,000)	(108,000)	(103,000)	(105,000)	(431,000)	(5,347)	241,263	176,043	176,043	588,001	(102,717)	(102,717)	(102,809)	(103,511)	(411,754)
Pre-tax income	**$559,000**	**$169,000**	**$144,000**	**$69,000**	**($34,000)**	**$348,000**	**($57,495)**	**($78,382)**	**($1,755)**	**($25,784)**	**($163,416)**	**($173,943)**	**($209,953)**	**($194,204)**	**($177,062)**	**($755,162)**
Income taxes:																
Current	518,000	95,000	132,000	121,000	70,000	418,000	(18,107)	(72,495)	(43,652)	(54,844)	(189,099)	(33,086)	(37,367)	(36,205)	(32,610)	(139,267)
Deferred	(92,000)	(1,000)	0	0	23,000	22,000	0	0	0	0	0	0	0	0	0	0
Total income taxes	$426,000	$94,000	$132,000	$121,000	$93,000	$440,000	($18,107)	($72,495)	($43,652)	($54,844)	($189,099)	($33,086)	($37,367)	($36,205)	($32,610)	($139,267)
tax rate	76.2%	55.6%	91.7%	175.4%	-273.5%	126.4%	31.5%	92.5%	2486.7%	212.7%	115.7%	19.0%	17.8%	18.6%	18.4%	18.4%
% deferred	-21.6%	-1.1%	0.0%	0.0%	24.7%	5.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Preferred dividends	(46,000)	(4,000)	-	-	-	(4,000)	-	-	-	-	-	-	-	-	-	-
Adjusted Net Income	($80,000)	$28,000	($28,000)	($98,000)	($180,000)	($274,000)	($90,587)	($59,793)	($1,387)	($25,302)	($177,069)	($189,765)	($220,872)	($205,621)	($191,284)	($807,542)
Special items, net of taxes	(59,000)	4,000	22,000	(107,000)	(42,000)	(123,000)	-	-	-	-	-	-	-	-	-	-
GAAP Income	**($139,000)**	**$32,000**	**($6,000)**	**($205,000)**	**($222,000)**	**($397,000)**	**($90,587)**	**($59,793)**	**($1,387)**	**($25,302)**	**($177,069)**	**($189,765)**	**($220,872)**	**($205,621)**	**($191,284)**	**($807,542)**
GAAP EPS - Diluted	($0.31)	$0.12	($0.02)	($0.68)	($0.73)	($1.30)	($0.30)	($0.20)	($0.00)	($0.08)	($0.58)	($0.62)	($0.72)	($0.67)	($0.63)	($2.65)
Adjusted EPS - Diluted	**($0.11)**	**$0.11**	**($0.09)**	**($0.32)**	**($0.60)**	**($0.90)**	**($0.30)**	**($0.20)**	**($0.00)**	**($0.08)**	**($0.58)**	**($0.62)**	**($0.72)**	**($0.67)**	**($0.63)**	**($2.65)**
Diluted shares outstanding	298,950	299,700	302,200	302,500	302,800	301,800	304,955	304,955	304,955	304,955	304,955	304,955	304,955	304,955	304,955	304,955
Diluted DCFPS	**$7.11**	**$2.12**	**$1.85**	**$1.73**	**$1.72**	**$7.41**	**$1.95**	**$2.09**	**$2.19**	**$2.27**	**$8.49**	**$1.61**	**$1.49**	**$1.52**	**$1.58**	**$6.19**
Margin Analysis ($/boe):																
E&P Revenue	$43.76	$41.84	$41.79	$38.23	$38.28	$39.94	$32.65	$23.23	$27.77	$27.55	$27.77	$30.96	$29.72	$30.22	$31.17	$30.52
E&P Production costs	26.63	23.28	24.91	24.41	24.81	24.34	25.46	25.01	25.26	25.13	25.21	24.80	24.77	24.76	24.78	24.78
E&P DD&A	17.15	17.22	17.21	17.73	17.61	17.45	17.68	17.34	17.26	17.33	17.40	17.28	17.27	17.24	17.24	17.26
E&P G&A	1.84	1.56	1.80	1.78	2.03	1.80	1.66	1.62	1.67	1.89	1.71	1.63	1.64	1.66	2.00	1.73
Interest	3.36	3.08	3.00	2.69	2.48	2.80	2.61	2.55	2.62	2.47	2.56	2.57	2.58	2.61	2.64	2.60
Cash taxes	5.13	3.53	4.95	4.23	2.25	3.69	(0.61)	(2.37)	(1.47)	(1.74)	(1.56)	(1.09)	(1.24)	(1.22)	(1.10)	(1.16)
Discretionary cash flow	21.04	23.57	20.99	18.25	16.74	19.75	19.97	20.84	22.46	21.99	21.32	16.18	15.11	15.54	16.17	15.75
E&P EBITDAX	$3,028,000	$817,000	$772,000	$720,000	$667,000	$2,976,000	$653,634	$641,329	$700,696	$715,366	$2,711,025	$534,483	$496,095	$504,295	$526,788	$2,061,662

Source: SFG Estimates

Exhibit 14: MGY Income Statement

Magnolia Oil & Gas	2018	1Q '19	2Q '19	3Q '19	4Q '19	2019	1Q '20E	2Q '20E	3Q '20E	4Q '20E	2020E	1Q '21E	2Q '21E	3Q '21E	4Q '21E	2021E
Commodity Prices																
Crude Oil (Spot WTI - $/bbl)	$64.81	$54.72	$59.90	$56.41	$56.94	$56.99	$48.00	$30.00	$35.00	$35.00	$37.00	$40.00	$40.00	$40.00	$40.00	$40.00
Nat Gas (HH Spot - $/MMbtu)	$3.11	$3.17	$2.65	$2.25	$2.50	$2.64	$1.95	$2.00	$2.20	$2.50	$2.16	$2.60	$2.25	$2.50	$2.65	$2.50
Daily Production																
Crude - bls/d	31,312	32,289	35,044	38,261	35,337	35,249	33,000	35,300	31,700	29,600	32,390	25,100	24,300	25,300	24,500	24,800
NGL - bls/d	9,537	12,044	11,648	13,533	13,630	12,721	13,300	13,600	13,300	13,000	13,299	12,300	12,000	11,900	11,700	11,973
Nat Gas - Mcf/d	74,962	108,478	110,516	116,989	116,185	113,074	114,000	113,300	109,800	106,600	110,910	99,900	98,800	97,200	96,000	97,962
Equivalent - boe/d	53,343	62,413	65,112	71,292	68,332	66,816	65,300	67,783	63,300	60,367	64,175	54,050	52,767	53,400	52,200	53,100
Income Statement																
Total revenues	$954,091	$218,674	$242,958	$244,799	$229,709	$936,140	$185,370	$130,283	$138,104	$134,965	$588,721	$126,990	$120,234	$127,520	$126,693	$501,437
Costs & expenses:																
Lease operating	$73,479	$21,518	$24,895	$24,344	$23,034	$93,791	$21,392	$22,206	$20,965	$19,993	$84,557	$17,026	$16,806	$17,195	$16,808	$67,835
Production taxes	$50,785	$14,401	$13,091	$13,333	$12,904	$53,729	$10,381	$7,296	$7,734	$7,558	$32,968	$6,984	$6,613	$7,014	$6,968	$27,579
DD&A	$361,698	$115,946	$126,102	$143,894	$141,255	$527,197	$130,731	$135,702	$128,119	$122,182	$516,734	$107,019	$105,639	$108,082	$105,653	$426,392
Exploration	$2,993	$6,455	$7,328	$7,550	$2,724	$24,057	$2,000	$2,000	$2,000	$2,000	$8,000	$2,000	$2,000	$2,000	$2,000	$8,000
G&A	$53,943	$13,764	$15,991	$14,516	$14,071	$58,342	$15,000	$15,000	$16,000	$18,000	$64,000	$16,000	$16,000	$17,000	$20,000	$69,000
Other	$30,046	$10,643	$8,804	$10,664	$10,324	$40,435	$9,819	$10,136	$9,653	$9,275	$38,883	$8,310	$8,222	$8,378	$8,223	$33,134
Total operating expense	$572,944	$185,159	$199,326	$217,130	$207,025	$808,640	$191,823	$194,839	$186,971	$181,509	$755,142	$159,839	$157,780	$162,168	$162,153	$641,941
Operating Income	$381,147	$33,515	$43,632	$27,669	$22,684	$127,500	($6,453)	($64,557)	($48,867)	($46,544)	($166,421)	($32,850)	($37,547)	($34,648)	($35,459)	($140,503)
Other expense (income):																
Interest Expense	($27,303)	($7,416)	($7,299)	($6,896)	($6,745)	($28,356)	($6,688)	($6,688)	($6,688)	($6,688)	($26,750)	($6,688)	($6,688)	($6,688)	($6,688)	($26,750)
Net Derivatives/ Other Income	($2,265)	$389	$115	$113	$3	$620	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total other expense (income)	(29,568)	(7,027)	(7,184)	(6,783)	(6,742)	(27,736)	(6,688)	(6,688)	(6,688)	(6,688)	(26,750)	(6,688)	(6,688)	(6,688)	(6,688)	(26,750)
Pre-tax income	**$351,579**	**$26,488**	**$36,448**	**$20,886**	**$15,942**	**$99,764**	**($13,141)**	**($71,244)**	**($55,555)**	**($53,232)**	**($193,171)**	**($39,537)**	**($44,234)**	**($41,335)**	**($42,147)**	**($167,253)**
Total income taxes	$45,825	$3,775	$5,145	$3,529	$2,311	$14,760	($1,840)	($9,974)	($7,778)	($7,452)	($27,044)	($5,535)	($6,193)	($5,787)	($5,901)	($23,415)
Reported Net Income	$305,754	$22,713	$31,303	$17,357	$13,631	$85,004	($11,301)	($61,270)	($47,777)	($45,779)	($166,127)	($34,002)	($38,041)	($35,548)	($36,246)	($143,838)
Non-controlling interest/Special items	($30,860)	$279	$67	($6,810)	($5,516)	($11,980)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Net Income after special items	**$274,894**	**$22,992**	**$31,370**	**$10,547**	**$8,115**	**$73,024**	**($11,301)**	**($61,270)**	**($47,777)**	**($45,779)**	**($166,127)**	**($34,002)**	**($38,041)**	**($35,548)**	**($36,246)**	**($143,838)**
Adjusted EPS - Diluted	**NM**	**$0.09**	**$0.12**	**$0.06**	**$0.05**	**$0.33**	**($0.04)**	**($0.24)**	**($0.19)**	**($0.18)**	**($0.65)**	**($0.13)**	**($0.15)**	**($0.14)**	**($0.14)**	**($0.56)**
Diluted shares outstanding	220,237	251,329	250,847	258,898	262,589	255,916	257,351	257,351	257,351	257,351	257,351	257,351	257,351	257,351	257,351	257,351
Discretionary Cashflow (DCF):																
Net Income	$305,754	$22,713	$31,303	$17,357	$13,631	$85,004	($11,301)	($61,270)	($47,777)	($45,779)	($166,127)	($34,002)	($38,041)	($35,548)	($36,246)	($143,838)
DD&A and ARO	363,386	117,274	127,475	145,288	142,671	532,708	132,231	137,202	129,619	123,682	522,734	108,519	107,139	109,582	107,153	432,392
Exploration & Abandonment	12,374	2,476	3,617	3,924	2,724	12,741	2,000	2,000	2,000	2,000	8,000	2,000	2,000	2,000	2,000	8,000
Deferred taxes	45,825	3,775	5,145	3,529	2,496	14,945	(1,840)	(9,974)	(7,778)	(7,452)	(27,044)	(5,535)	(6,193)	(5,787)	(5,901)	(23,415)
Other	(3,865)	5,762	6,694	435	(1,358)	11,533	0	0	0	0	0	0	0	0	0	0
Discretionary cash flow (DCF)	$723,474	$154,432	$177,349	$173,362	$162,877	$668,020	$123,590	$70,458	$78,564	$74,950	$347,563	$73,482	$67,405	$72,747	$69,506	$283,139
Diluted DCFPS	**$3.28**	**$0.61**	**$0.71**	**$0.67**	**$0.62**	**$2.61**	**$0.48**	**$0.27**	**$0.31**	**$0.29**	**$1.35**	**$0.29**	**$0.26**	**$0.28**	**$0.27**	**$1.10**
Margin Analysis ($/boe):																
E&P Revenue	$49.00	$38.93	$41.00	$37.32	$36.54	$38.39	$31.19	$21.12	$23.71	$24.30	$25.06	$26.11	$25.04	$25.96	$26.38	$25.87
Production expense	6.38	6.39	6.41	5.74	5.72	6.05	5.35	4.78	4.93	4.96	5.00	4.94	4.88	4.93	4.95	4.92
DD&A	18.58	20.64	21.28	21.94	22.47	21.62	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00
G&A	2.77	2.88	3.22	2.64	2.67	2.85	2.94	2.84	3.18	3.69	3.15	3.80	3.85	3.97	4.69	4.08
Interest	1.40	1.32	1.23	1.05	1.07	1.16	1.13	1.08	1.15	1.20	1.14	1.37	1.39	1.36	1.39	1.38
Discretionary cash flow	37.16	27.49	29.93	26.43	25.91	27.39	20.80	11.42	13.49	13.50	14.80	15.11	14.04	14.81	14.47	14.61
EBITDAX	$745,322	$160,065	$181,665	$183,449	$168,082	$693,261	$130,277	$77,146	$85,252	$81,638	$374,313	$80,169	$74,092	$79,434	$76,194	$309,889

Source: SFG Estimates

Exhibit 15: MRO Income Statement

Marathon Oil Corp (MRO)	2018	1Q '19	2Q '19	3Q '19	4Q '19	2019	1Q '20E	2Q '20E	3Q '20E	4Q '20E	2020E	1Q '21E	2Q '21E	3Q '21E	4Q '21E	2021E
Commodity Prices																
Crude Oil (WTI - $/bbl)	$64.81	$54.72	$59.90	$56.41	$56.94	$56.99	$48.00	$30.00	$35.00	$35.00	$37.00	$40.00	$40.00	$40.00	$40.00	$40.00
Crude Oil (Brent - $/bbl)	$70.94	$59.96	$68.53	$62.01	$62.40	$63.23	$52.00	$33.50	$38.50	$38.50	$40.63	$43.75	$43.75	$43.75	$43.75	$43.75
Nat Gas (Henry Hub - $/MMbtu)	$3.09	$3.17	$2.65	$2.25	$2.50	$2.64	$1.95	$2.00	$2.20	$2.50	$2.16	$2.60	$2.25	$2.50	$2.65	$2.50
Realized Oil - $/bbl	$60.70	$48.97	$59.05	$54.42	$54.42	$54.35	$49.57	$32.31	$37.05	$37.12	$39.03	$38.76	$38.76	$38.76	$38.77	$38.76
Realized NGL - $/bbl	$20.77	$13.80	$12.76	$9.91	$13.53	$12.44	$10.88	$7.62	$7.53	$9.77	$8.96	$9.37	$8.55	$7.94	$9.49	$8.84
Realized Nat Gas - $/MMbtu	$1.58	$1.79	$1.17	$1.17	$1.26	$1.33	$1.01	$0.93	$1.09	$1.46	$1.11	$1.33	$1.04	$1.23	$1.40	$1.25
Daily Production																
Crude - bbl/d	208,926	200,000	220,000	217,000	209,000	211,540	209,754	208,632	206,940	202,965	207,061	200,808	202,526	205,017	204,293	203,176
NGL - bbl/d	66,019	63,000	74,000	71,000	67,000	68,767	72,311	69,585	67,184	62,996	68,003	62,935	61,945	61,381	60,318	61,637
Nat Gas - Mcf/d	864,959	734,000	862,000	835,000	807,000	809,770	765,361	732,614	708,014	599,222	701,042	663,140	645,989	632,214	616,455	639,302
Equivalent - boe/d	419,105	385,333	437,667	427,167	410,500	415,268	409,625	400,320	392,126	365,831	391,904	374,266	372,136	371,767	367,354	371,363
Income Statement *(figures in $000s, except per share)*																
Revenues:																
Oil & Gas sales	5,902,000	1,200,000	1,381,000	1,249,000	1,233,000	5,063,000	1,087,897	723,867	823,239	830,020	3,465,023	832,759	823,536	847,284	860,448	3,364,027
Marketing/Mid-stream, net	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total revenues	$5,902,000	1,200,000	1,381,000	1,249,000	1,233,000	$5,063,000	1,087,897	723,867	823,239	830,020	$3,465,023	832,759	823,536	847,284	860,448	$3,364,027
Costs & expenses:																
Production costs	1,716,000	$413,000	$442,000	$382,000	$391,000	1,628,000	$359,287	$328,949	$333,302	$321,899	1,343,436	$315,532	$317,062	$322,293	$320,614	1,275,501
Exploration	289,000	59,000	26,000	22,000	42,000	149,000	25,000	25,000	25,000	25,000	100,000	25,000	25,000	25,000	25,000	100,000
DD&A	2,441,000	554,000	605,000	622,000	616,000	2,397,000	606,722	593,814	589,175	568,202	2,357,913	564,153	569,312	577,620	572,160	2,283,246
G&A	375,000	94,000	85,000	82,000	93,000	354,000	83,000	83,000	85,000	93,000	344,000	84,000	84,000	89,000	95,000	352,000
Impairments	75,000	6,000	18,000	-	-	24,000	-	-	-	-	-	-	-	-	-	-
Other	19,000	-	2,000	-	-	2,000	-	-	-	-	-	-	-	-	-	-
Total operating expense	$4,915,000	$1,126,000	$1,178,000	$1,108,000	$1,142,000	$4,554,000	$1,074,009	$1,030,763	$1,032,477	$1,008,100	$4,145,349	$988,685	$995,374	$1,013,913	$1,012,775	$4,010,746
Operating Income	$987,000	$74,000	$203,000	$141,000	$91,000	$509,000	$13,888	($306,896)	($209,238)	($178,081)	($680,326)	($155,926)	($171,838)	($166,629)	($152,326)	($646,719)
Other income (expense):																
Other income (expense)	361,000	51,000	46,000	29,000	23,000	149,000	5,000	20,000	25,000	25,000	75,000	15,000	20,000	27,500	35,000	97,500
Gain (loss) on asset sales	319,000	42,000	(8,000)	22,000	(6,000)	50,000	-	-	-	-	-	-	-	-	-	-
Net hedges	(14,000)	(91,000)	16,000	47,000	(44,000)	(72,000)	-	-	-	-	-	-	-	-	-	-
Interest expense	(226,000)	(49,000)	(64,000)	(64,000)	(67,000)	(244,000)	(60,002)	(60,002)	(60,002)	(60,002)	(240,006)	(60,002)	(60,002)	(60,002)	(60,002)	(240,006)
Total other expense (income)	440,000	(47,000)	(10,000)	34,000	(94,000)	(117,000)	(55,002)	(40,002)	(35,002)	(35,002)	(165,006)	(45,002)	(40,002)	(32,502)	(25,002)	(142,506)
Pre-tax income	**$1,427,000**	**$27,000**	**$193,000**	**$175,000**	**($3,000)**	**$392,000**	**($41,113)**	**($346,897)**	**($244,240)**	**($213,082)**	**($845,333)**	**($200,927)**	**($211,840)**	**($199,131)**	**($177,328)**	**($789,226)**
Income taxes:																
Current	279,000	(116,000)	34,000	11,000	17,000	(54,000)	3,919	(609)	571	2,088	5,969	1,673	1,649	1,626	1,585	6,533
Deferred	52,000	(31,000)	(2,000)	(1,000)	0	(34,000)	(12,552)	(72,239)	(51,862)	(46,836)	(183,489)	(43,868)	(46,136)	(43,443)	(38,824)	(172,270)
Total income taxes	$331,000	($147,000)	$32,000	$10,000	$17,000	($88,000)	($8,634)	($72,848)	($51,290)	($44,747)	($177,520)	($42,195)	($44,486)	($41,817)	($37,239)	($165,737)
tax rate	23.2%	35.0%	35.0%	35.0%	35.0%	-22.4%	35.0%	35.0%	35.0%	35.0%	21.0%	35.0%	35.0%	35.0%	35.0%	21.0%
% deferred	15.7%	65.0%	65.0%	65.0%	65.0%	38.6%	65.0%	65.0%	65.0%	65.0%	103.4%	65.0%	65.0%	65.0%	65.0%	103.9%
Preferred dividends	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Income	$1,096,000	$174,000	$161,000	$165,000	($20,000)	$480,000	($32,479)	($274,049)	($192,950)	($168,335)	($667,813)	($158,732)	($167,354)	($157,313)	($140,089)	($623,488)
Special items, net of taxes	(495,000)	82,000	28,000	(54,000)	75,000	131,000	-	-	-	-	-	-	-	-	-	-
Net Income after special items	**$601,000**	**$256,000**	**$189,000**	**$111,000**	**$55,000**	**$611,000**	**($32,479)**	**($274,049)**	**($192,950)**	**($168,335)**	**($667,813)**	**($158,732)**	**($167,354)**	**($157,313)**	**($140,089)**	**($623,488)**
Reported EPS - Diluted	$1.30	$0.21	$0.20	$0.21	($0.03)	$0.59	($0.04)	($0.34)	($0.24)	($0.21)	($0.84)	($0.20)	($0.21)	($0.20)	($0.18)	($0.78)
Recurring EPS - Diluted	**$0.71**	**$0.31**	**$0.23**	**$0.14**	**$0.07**	**$0.76**	**($0.04)**	**($0.34)**	**($0.24)**	**($0.21)**	**($0.84)**	**($0.20)**	**($0.21)**	**($0.20)**	**($0.18)**	**($0.78)**
Diluted shares outstanding	846,250	820,000	814,000	803,000	800,000	809,250	796,000	796,000	796,000	796,000	796,000	796,000	796,000	796,000	796,000	796,000
Diluted DCFPS	**$3.82**	**$0.83**	**$0.95**	**$0.94**	**$0.86**	**$3.58**	**$0.76**	**$0.36**	**$0.49**	**$0.50**	**$2.11**	**$0.51**	**$0.50**	**$0.53**	**$0.55**	**$2.09**
Margin Analysis ($/boe):																
E&P Revenue	$38.58	$34.60	$34.67	$31.78	$32.65	$33.40	$29.19	$19.87	$22.82	$24.66	$24.16	$24.72	$24.32	$24.77	$25.46	$24.82
Production costs	11.22	11.91	11.10	9.72	10.35	10.74	9.64	9.03	9.24	9.56	9.37	9.37	9.36	9.42	9.49	9.41
DD&A	15.96	15.97	15.19	15.83	16.31	15.81	16.28	16.30	16.33	16.88	16.44	16.75	16.81	16.89	16.93	16.84
G&A	2.10	2.31	1.68	1.76	2.07	1.94	1.88	1.92	2.00	2.32	2.02	2.08	2.07	2.19	2.37	2.18
Interest	1.48	1.41	1.61	1.63	1.77	1.61	1.61	1.65	1.66	1.78	1.67	1.78	1.77	1.75	1.78	1.77
Cash taxes	1.82	(3.34)	0.85	0.28	0.45	(0.36)	0.11	(0.02)	0.02	0.06	0.04	0.05	0.05	0.05	0.05	0.05
Discretionary cash flow	21.13	19.67	19.51	19.26	18.14	19.14	16.22	7.98	10.74	11.83	11.72	12.04	11.81	12.31	12.97	12.28
E&P EBITDAX	$3,845,000	$707,000	$870,000	$798,000	$764,000	$3,139,000	$658,610	$324,919	$417,937	$430,121	$1,831,586	$447,227	$436,474	$449,991	$459,834	$1,793,526

Source: SFG Estimates

Exhibit 16: NBL Income Statement

Noble Energy NBL	2018	1Q '19	2Q '19	3Q '19	4Q '19	2019	1Q '20E	2Q '20E	3Q '20E	4Q '20E	2020E	1Q '21E	2Q '21E	3Q '21E	4Q '21E	2021E
Commodity Prices																
Crude Oil (WTI - $/bbl)	$64.81	$54.72	$59.90	$56.41	$56.94	$56.99	$48.00	$30.00	$35.00	$35.00	$37.00	$40.00	$40.00	$40.00	$40.00	$40.00
Crude Oil (Brent - $/bbl)	$70.94	$59.96	$68.53	$62.01	$62.40	$63.23	$52.00	$33.50	$38.50	$38.50	$40.63	$43.75	$43.75	$43.75	$43.75	$43.75
Nat Gas (Henry Hub - $/MMbtu)	$3.09	$3.17	$2.65	$2.25	$2.50	$2.64	$1.95	$2.00	$2.20	$2.50	$2.16	$2.60	$2.25	$2.50	$2.65	$2.50
Daily Production																
Crude - bbl/d	131,723	126,000	130,000	143,000	139,000	134,559	135,352	131,817	129,979	122,308	129,844	122,161	125,048	127,105	124,053	124,604
NGL - bbl/d	67,496	63,000	69,000	81,000	77,000	72,562	73,188	70,468	68,517	65,927	69,512	64,545	65,744	66,431	64,674	65,352
Nat Gas - Mcf/d	921,241	884,000	902,000	963,000	945,000	923,775	1,099,338	1,092,985	1,111,920	1,098,092	1,100,608	1,219,309	1,214,713	1,254,728	1,269,076	1,239,635
Equivalent - boe/d	352,759	336,333	349,333	384,500	373,500	361,083	391,763	384,450	383,817	371,250	382,791	389,924	393,244	402,657	400,240	396,561
Income Statement *(figures in $000s, except per share)*																
Revenues:																
Oil & Gas sales	4,461,000	937,000	954,000	1,003,000	1,010,000	3,904,000	930,703	628,876	714,729	721,113	2,995,421	824,435	825,050	838,853	848,449	3,336,788
Other	168,000	25,000	12,000	13,000	21,000	71,000	15,000	20,000	20,000	25,000	80,000	45,000	45,000	50,000	50,000	190,000
Total revenues	$4,629,000	962,000	966,000	1,016,000	1,031,000	$3,975,000	945,703	648,876	734,729	746,113	$3,075,421	869,435	870,050	888,853	898,449	$3,526,788
Costs & expenses:																
Production costs	771,000	$200,000	$163,000	$189,000	$160,000	712,000	$187,199	$167,085	$171,281	$164,530	690,095	$178,235	$184,089	$198,361	$196,741	757,426
GP&T	393,000	$102,000	$96,000	$108,000	$111,000	417,000	$110,857	$107,305	$100,259	$96,821	415,242	$90,230	$92,459	$94,917	$91,858	369,465
Exploration	129,000	24,000	33,000	25,000	120,000	202,000	25,000	25,000	25,000	25,000	100,000	25,000	25,000	25,000	25,000	100,000
DD&A	1,934,000	508,000	528,000	583,000	578,000	2,197,000	516,018	501,142	500,556	484,615	2,002,332	466,194	472,952	485,418	474,331	1,898,895
G&A	385,000	102,000	105,000	91,000	118,000	416,000	91,000	94,000	94,000	98,000	377,000	96,000	96,000	97,000	101,000	390,000
Impairments	1,487,000	-	-	-	1,160,000	1,160,000	-	-	-	-	-	-	-	-	-	-
Other	22,000	117,000	9,000	29,000	35,000	190,000	-	-	-	-	-	-	-	-	-	-
Total operating expense	$5,121,000	$1,053,000	$934,000	$1,025,000	$2,282,000	$5,294,000	$930,074	$894,533	$891,095	$868,966	$3,584,669	$855,659	$870,500	$900,696	$888,931	$3,515,786
Operating Income	($492,000)	($91,000)	$32,000	($9,000)	($1,251,000)	($1,319,000)	$15,629	($245,657)	($156,366)	($122,853)	($509,247)	$13,776	($450)	($11,843)	$9,518	$11,002
Other income (expense):																
Other income (expense)	403,000	(70,000)	(64,000)	(69,000)	(67,000)	(270,000)	(84,370)	(84,370)	(84,370)	(84,370)	(337,481)	(84,370)	(84,370)	(81,520)	(80,095)	(330,356)
Gain (loss) on asset sales	177,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Net hedges	63,000	(212,000)	60,000	129,000	(120,000)	(143,000)	86,764	194,917	111,250	104,487	497,419	1,008	892	64	258	2,222
Interest expense	(11,000)	-	-	-	(44,000)	(44,000)	-	-	-	-	-	-	-	-	-	-
Total other expense (income)	632,000	(282,000)	(4,000)	60,000	(231,000)	(457,000)	2,394	110,547	26,880	20,117	159,938	(83,362)	(83,478)	(81,456)	(79,838)	(328,134)
Pre-tax income	**$140,000**	**($373,000)**	**$28,000**	**$51,000**	**($1,482,000)**	**($1,776,000)**	**$18,023**	**($135,110)**	**($129,486)**	**($102,737)**	**($349,309)**	**($69,586)**	**($83,928)**	**($93,299)**	**($70,320)**	**($317,132)**
Income taxes:																
Current	196,000	16,000	21,000	24,000	30,000	91,000	39,472	33,344	39,688	42,394	154,898	45,384	42,913	45,515	46,738	180,550
Deferred	(70,000)	(100,000)	(1,000)	(9,000)	(324,000)	(434,000)	(35,687)	(61,717)	(66,880)	(63,969)	(228,253)	(59,997)	(60,538)	(65,108)	(61,505)	(247,148)
Total income taxes	$126,000	($84,000)	$20,000	$15,000	($294,000)	($343,000)	$3,785	($28,373)	($27,192)	($21,575)	($73,355)	($14,613)	($17,625)	($19,593)	($14,767)	($66,598)
tax rate	90.0%	35.0%	35.0%	35.0%	35.0%	19.3%	35.0%	35.0%	35.0%	35.0%	21.0%	35.0%	35.0%	35.0%	35.0%	21.0%
% deferred	-55.6%	65.0%	65.0%	65.0%	65.0%	126.5%	65.0%	65.0%	65.0%	65.0%	311.2%	65.0%	65.0%	65.0%	65.0%	371.1%
Preferred dividends	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Income attributable to non-controlling interest	80,000	24,000	18,000	19,000	18,000	79,000	25,000	25,000	25,000	25,000	100,000	25,000	25,000	25,000	25,000	100,000
Net Income	($66,000)	($313,000)	($10,000)	$17,000	($1,206,000)	($1,512,000)	($10,762)	($131,737)	($127,294)	($106,162)	($375,954)	($79,973)	($91,303)	($98,706)	($80,552)	($350,534)
Special items, net of taxes	504,000	269,000	(39,000)	(64,000)	1,180,000	1,346,000	-	-	-	-	-	-	-	-	-	-
Net Income after special items	**$438,000**	**($44,000)**	**($49,000)**	**($47,000)**	**($26,000)**	**($166,000)**	**($10,762)**	**($131,737)**	**($127,294)**	**($106,162)**	**($375,954)**	**($79,973)**	**($91,303)**	**($98,706)**	**($80,552)**	**($350,534)**
Reported EPS - Diluted	($0.14)	($0.65)	($0.02)	$0.04	($2.52)	($3.16)	($0.02)	($0.28)	($0.27)	($0.22)	($0.79)	($0.17)	($0.19)	($0.21)	($0.17)	($0.73)
Recurring EPS - Diluted	**$0.90**	**($0.09)**	**($0.10)**	**($0.10)**	**($0.05)**	**($0.35)**	**($0.02)**	**($0.28)**	**($0.27)**	**($0.22)**	**($0.79)**	**($0.17)**	**($0.19)**	**($0.21)**	**($0.17)**	**($0.73)**
Diluted shares outstanding	484,729	478,000	478,000	480,000	478,000	478,504	478,000	478,000	478,000	478,000	478,000	478,000	478,000	478,000	478,000	478,000
Diluted DCFPS	**$4.92**	**$0.97**	**$1.06**	**$1.15**	**$1.13**	**$4.31**	**$1.11**	**$0.78**	**$0.78**	**$0.80**	**$3.47**	**$0.83**	**$0.82**	**$0.82**	**$0.84**	**$3.32**
Margin Analysis ($/boe):																
E&P Revenue	$23.37	$20.56	$21.94	$20.79	$21.04	$21.08	$16.75	$10.09	$11.68	$11.38	$12.50	$12.45	$12.55	$12.48	$12.31	$12.45
Production costs	6.11	6.71	5.22	5.43	4.73	5.49	5.33	4.86	4.93	4.90	5.01	5.16	5.24	5.44	5.42	5.32
DD&A	15.34	17.04	16.90	16.74	17.10	16.94	14.70	14.59	14.40	14.42	14.53	13.49	13.46	13.30	13.08	13.33
G&A	2.56	2.95	2.69	2.15	2.99	2.68	2.14	2.27	2.24	2.44	2.27	2.32	2.28	2.22	2.34	2.29
Interest	2.24	2.21	2.02	1.92	1.89	2.00	2.40	2.46	2.43	2.51	2.45	2.44	2.40	2.23	2.21	2.32
Cash taxes	1.55	0.54	0.67	0.69	0.89	0.70	1.12	0.97	1.14	1.26	1.12	1.31	1.22	1.25	1.29	1.27
Discretionary cash flow	18.90	15.59	16.23	15.79	16.00	15.91	15.17	10.88	10.71	11.32	12.04	11.50	11.16	10.76	11.12	11.13
E&P EBITDAX	$3,115,000	$797,000	$598,000	$641,000	$640,000	$2,676,000	$572,648	$296,485	$385,190	$402,762	$1,657,085	$520,971	$513,502	$514,575	$524,849	$2,073,897

Source: SFG Estimates

Exhibit 17: OAS Income Statement

Oasis Petroleum	2018	1Q '19	2Q '19	3Q '19	4Q '19	2019	1Q '20E	2Q '20E	3Q '20E	4Q '20E	2020E	1Q '21E	2Q '21E	3Q '21E	4Q '21E	2021E
Commodity Prices																
WTI Crude Oil ($/bbl)	$64.81	$54.72	$59.90	$56.41	$56.94	$56.99	$48.00	$30.00	$35.00	$35.00	$37.00	$40.00	$40.00	$40.00	$40.00	$40.00
Henry Hub Nat Gas ($/mmbtu)	$3.11	$3.17	$2.65	$2.25	$2.50	$2.64	$1.95	$2.00	$2.20	$2.50	$2.16	$2.60	$2.25	$2.50	$2.65	$2.50
Realized Oil ($/bbl)	$52.38	$55.79	$56.79	$56.03	$54.96	$55.89	$51.76	$45.37	$41.82	$42.00	$45.21	$36.96	$37.04	$36.31	$36.38	$36.68
Realized Nat Gas ($/mmbtu)	$2.89	$3.65	$2.43	$1.95	$2.85	$2.72	$1.95	$1.90	$1.94	$2.38	$2.04	$2.47	$2.03	$2.13	$2.39	$2.25
Daily Production																
Crude - bls/d	63,148	66,044	61,224	62,816	60,108	62,533	54,600	54,900	55,200	54,550	54,813	51,300	50,100	48,450	46,950	49,186
Nat Gas - mcf/d	116,247	154,000	139,380	155,391	163,762	153,166	147,750	146,750	146,550	144,250	146,320	137,150	133,050	128,000	123,150	130,293
Equivalent - boe/d	82,523	91,711	84,454	88,715	87,402	88,060	79,225	79,358	79,625	78,592	79,199	74,158	72,275	69,783	67,475	70,901
STATEMENT OF OPERATIONS																
(data in thousands, except per share)																
Revenues:																
Oil & natural gas sales	$1,670,748	$400,074	$391,209	$381,526	$386,024	$1,558,833	$284,549	$188,551	$218,318	$221,308	$912,726	$228,092	$219,440	$215,383	$211,263	$874,178
Other	23,780	$2,055	$2,692	$3,444	$4,633	12,824	$2,623	$2,541	$2,514	$2,454	10,131	$2,221	$2,158	$2,072	$1,971	$8,423
Total revenues	$1,694,528	$402,129	$393,901	$384,970	$390,657	$1,571,657	$287,172	$191,092	$220,831	$223,762	$922,857	$230,313	$221,598	$217,455	$213,234	$882,600
Costs & expenses:																
Production costs	327,608	88,062	84,370	78,774	84,770	335,976	72,168	64,541	67,628	67,252	271,589	63,192	61,878	60,533	58,808	244,410
Gathering, transport, & marketing	106,618	34,950	28,488	32,659	32,709	128,806	29,827	29,581	29,790	29,310	118,509	26,851	26,358	25,613	24,655	103,476
DD&A	636,296	189,833	177,358	210,832	209,169	787,192	180,237	180,540	183,138	180,761	724,675	166,856	164,426	160,502	155,193	646,976
Exploration	28,007	830	884	652	4,289	6,655	1,000	1,000	1,000	1,000	4,000	1,000	1,000	1,000	1,000	4,000
G&A	121,346	34,459	30,926	52,860	25,261	143,506	25,000	25,000	28,000	34,000	112,000	25,000	25,000	28,000	34,000	112,000
Change in production plan liability	384,228	629	24	0	9,604	10,257	0	0	0	0	0	0	0	0	0	0
Other	(25,172)	0	0	0	889	889	0	0	0	0	0	0	0	0	0	0
Total operating expense	$1,578,931	$348,763	$322,050	$375,777	$366,691	$1,413,281	$308,232	$300,663	$309,555	$312,324	$1,230,773	$282,899	$278,661	$275,648	$273,655	$1,110,862
Operating Income	$115,597	$53,366	$71,851	$9,193	$23,966	$158,376	($21,059)	($109,571)	($88,724)	($88,562)	($307,916)	($52,586)	($57,063)	($58,193)	($60,420)	($228,262)
Other expense (income):																
Interest Expense	(159,085)	(44,468)	(43,186)	(43,897)	(44,672)	(176,223)	(42,206)	(42,403)	(42,318)	(41,961)	(168,888)	(41,704)	(41,803)	(42,029)	(41,850)	(167,386)
Unrealized hedging loss (gain)	241,985	(131,057)	44,566	40,799	(79,720)	(125,412)	0	0	0	0	0	0	0	0	0	0
Other expense (income)	(10,312)	(2,968)	0	(279)	4,046	799	0	0	0	0	0	0	0	0	0	0
Total other expense (income)	(140,940)	(165,047)	(8,437)	3,746	(112,000)	(281,738)	(8,923)	54,767	12,396	12,754	70,994	(38,104)	(38,163)	(42,029)	(41,850)	(160,146)
Pre-tax income	**($25,343)**	**($111,681)**	**$63,414**	**$12,939**	**($88,034)**	**($123,362)**	**($29,982)**	**($54,804)**	**($76,328)**	**($75,808)**	**($236,922)**	**($90,689)**	**($95,226)**	**($100,222)**	**($102,271)**	**($388,408)**
Income taxes	($5,843)	($3,703)	$12,240	($17,372)	($23,880)	($32,715)	($7,495)	($13,701)	($19,082)	($18,952)	($59,231)	($22,672)	($23,806)	($25,055)	($25,568)	($97,102)
Less: Income attributable to noncontrolling interests	($15,796)	($6,904)	($8,417)	($10,023)	($12,252)	($37,596)	($10,000)	($10,000)	($10,000)	($10,000)	($40,000)	($10,000)	($10,000)	($10,000)	($10,000)	($40,000)
Reported Net Income	($35,296)	($114,882)	$42,757	$20,288	($76,406)	($128,243)	($32,486)	($51,103)	($67,246)	($66,856)	($217,692)	($78,017)	($81,419)	($85,166)	($86,703)	($331,306)
Special items, net of taxes	114,891	107,941	(31,752)	(36,301)	71,027	110,915	-	-	-	-	-	-	-	-	-	-
Net Income after special items	**$79,595**	**($6,941)**	**$11,005**	**($16,013)**	**($5,379)**	**($17,328)**	**($32,486)**	**($51,103)**	**($67,246)**	**($66,856)**	**($217,692)**	**($78,017)**	**($81,419)**	**($85,166)**	**($86,703)**	**($331,306)**
Reported EPS - Diluted	($0.11)	($0.37)	$0.14	$0.06	($0.24)	($0.41)	($0.10)	($0.16)	($0.21)	($0.21)	($0.69)	($0.25)	($0.26)	($0.27)	($0.27)	($1.05)
Recurring EPS - Diluted	**$0.31**	**($0.02)**	**$0.03**	**($0.05)**	**($0.02)**	**($0.06)**	**($0.10)**	**($0.16)**	**($0.21)**	**($0.21)**	**($0.69)**	**($0.25)**	**($0.26)**	**($0.27)**	**($0.27)**	**($1.05)**
Diluted shares outstanding	309,722	314,464	314,982	315,135	315,416	314,999	315,416	315,416	315,416	315,416	315,416	315,416	315,416	315,416	315,416	315,416
Discretionary Cashflow (DCF):																
Discretionary cash flow (DCF)	$796,764	$215,413	$220,473	$215,413	$222,982	$874,281	$159,255	$134,736	$115,809	$115,953	$525,753	$85,167	$78,200	$69,280	$63,922	$296,568
Diluted DCFPS	**$2.57**	**$0.69**	**$0.70**	**$0.68**	**$0.71**	**$2.78**	**$0.50**	**$0.43**	**$0.37**	**$0.37**	**$1.67**	**$0.27**	**$0.25**	**$0.22**	**$0.20**	**$0.94**
Margin Analysis ($/boe):																
E&P Revenue	$59.66	$43.05	$47.73	$41.33	$41.06	$43.24	$30.08	$7.99	$17.62	$18.37	$18.51	$29.06	$28.30	$29.11	$29.67	$29.02
Production costs	10.88	10.67	10.98	9.65	10.54	10.45	10.01	8.94	9.23	9.30	9.37	9.47	9.41	9.43	9.47	9.44
DD&A	21.12	23.00	23.08	25.83	26.01	24.49	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
G&A (ex non-cash comp.)	3.06	3.08	2.86	5.44	2.24	3.42	2.36	2.35	2.73	3.32	2.69	2.55	2.58	3.12	3.87	3.01
Interest	5.28	5.39	5.62	5.38	5.56	5.48	5.85	5.87	5.78	5.80	5.83	6.25	6.36	6.55	6.74	6.47
Cash taxes	0.00	(0.02)	0.01	0.01	(0.00)	(0.00)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Discretionary cash flow	26.45	26.10	28.69	26.39	27.73	27.20	22.09	18.66	15.81	16.04	18.14	12.76	11.89	10.79	10.30	11.46
EBITDAX	$958,682	$269,346	$249,610	$256,640	$263,953	$1,039,549	$201,461	$177,139	$158,128	$157,913	$694,641	$126,871	$120,002	$111,309	$105,772	$463,954

Source: SFG Estimates

Exhibit 18: OXY Income Statement

Occidental Petroleum Corp (OXY)	1Q '19	2Q '19	3Q '19	4Q '19	2019	1Q '20E	2Q '20E	3Q '20E	4Q '20E	2020E	2021E
Commodity Prices											
Crude Oil (WTI - $/bbl)	$54.72	$59.90	$56.41	$56.94	$56.99	$48.00	$30.00	$35.00	$35.00	$37.00	$40.00
Crude Oil (Brent - $/bbl)	$59.96	$68.53	$62.01	$62.40	$63.23	$52.00	$33.50	$38.50	$38.50	$40.63	$43.75
Nat Gas (Henry Hub - $/MMbtu)	$3.17	$2.65	$2.25	$2.50	$2.64	$1.95	$2.00	$2.20	$2.50	$2.16	$2.50
Daily Production											
Crude - bbl/d	449,000	461,000	639,000	768,000	580,288	757,841	753,792	731,502	724,800	741,908	710,921
NGL - bbl/d	113,000	121,000	201,000	261,000	174,479	262,711	259,276	253,138	247,809	255,705	238,841
Nat Gas - Mcf/d	940,000	954,000	1,643,000	2,240,000	1,448,356	2,165,365	2,153,873	2,105,973	2,057,520	2,120,470	1,995,887
Equivalent - boe/d	718,667	741,000	1,113,833	1,402,333	996,160	1,381,446	1,372,047	1,335,636	1,315,529	1,351,025	1,282,410
Income Statement *(figures in $000s, except per share)*											
Total Oil & Gas Revenues	2,351,000	2,718,000	3,821,000	4,533,000	$13,423,000	3,945,040	2,893,211	3,260,644	3,266,514	$13,365,408	$12,800,930
Production costs	$849,611	$862,549	$1,385,045	$1,631,896	4,729,101	$1,589,055	$1,516,269	$1,515,031	$1,498,212	6,118,567	5,877,479
Exploration	36,000	35,000	63,000	112,000	246,000	75,000	75,000	75,000	100,000	325,000	200,000
DD&A	795,000	852,000	1,450,000	1,897,000	4,994,000	1,815,582	1,795,717	1,764,031	1,734,802	7,110,132	6,759,438
G&A/Other	186,389	242,451	451,955	262,104	1,142,899	375,000	350,000	320,000	300,000	1,345,000	1,050,000
Total operating expense	$1,867,000	$1,992,000	$3,350,000	$3,903,000	$11,112,000	$3,854,637	$3,736,987	$3,674,062	$3,633,013	$14,898,699	$13,886,917
E&P Pre-tax Income	$484,000	$726,000	$471,000	$630,000	$2,311,000	$90,402	($843,775)	($413,418)	($366,500)	($1,533,290)	($1,085,987)
Midstream Pre-tax Income	$279,000	$331,000	$155,000	$200,000	$965,000	($79,040)	($74,040)	($74,040)	($74,040)	($301,160)	($288,160)
Chemicals Pre-tax Income	$265,000	$208,000	$207,000	$119,000	$799,000	$148,800	$153,500	$191,000	$153,500	$646,800	$767,000
Total Pre-tax Income	$1,028,000	$1,265,000	$833,000	$949,000	$4,075,000	$160,162	($764,315)	($296,458)	($287,040)	($1,187,650)	($607,147)
Corporate											
Interest expense	($83,000)	($86,000)	($295,000)	($416,000)	(880,000)	($370,550)	($353,826)	($353,826)	($353,826)	(1,432,027)	(1,362,984)
Other expense	($89,000)	($131,000)	($60,000)	($493,000)	(773,000)	($79,360)	($35,823)	($50,248)	($42,893)	(208,325)	(130,681)
Total other expense (income)	(172,000)	(217,000)	(355,000)	(909,000)	(1,653,000)	(449,910)	(389,649)	(404,074)	(396,719)	(1,640,351)	(1,493,665)
Pre-tax income	**$856,000**	**$1,048,000**	**$478,000**	**$40,000**	**$2,422,000**	**($289,747)**	**($1,153,965)**	**($700,531)**	**($683,759)**	**($2,828,002)**	**($2,100,812)**
Total income taxes	$225,000	$319,000	$267,000	$109,000	$920,000	$57,081	($180,188)	($64,102)	($61,033)	($248,242)	($88,594)
Preferred dividends	-	-	118,000	200,000	318,000	200,000	200,000	200,000	200,000	800,000	800,000
Core Net Income	**631,000**	**729,000**	**$93,000**	**(269,000)**	**1,184,000**	**(546,828)**	**(1,173,776)**	**(836,430)**	**(822,725)**	**(3,379,759)**	**(2,812,218)**
Adjustments, net	-	(94,000)	(1,124,000)	(1,070,000)	(2,288,000)	-	-	-	-	-	-
GAAP Net Income	$631,000	$635,000	($1,031,000)	($1,339,000)	($1,104,000)	($546,828)	($1,173,776)	($836,430)	($822,725)	($3,379,759)	($2,812,218)
Reported EPS - Diluted	$0.84	$0.85	($1.22)	($1.50)	($1.36)	($0.61)	($1.31)	($0.93)	($0.92)	($3.78)	($3.14)
Core EPS - Diluted	**$0.84**	**$0.97**	**$0.11**	**($0.30)**	**$1.46**	**($0.61)**	**($1.31)**	**($0.93)**	**($0.92)**	**($3.78)**	**($3.14)**
Diluted shares outstanding	750,500	749,500	845,700	894,900	810,150	894,900	894,900	894,900	894,900	894,900	894,900
Diluted DCFPS	**$2.44**	**$2.69**	**$2.37**	**$2.63**	**$10.13**	**$1.95**	**$1.07**	**$1.49**	**$1.51**	**$6.02**	**$6.19**
EBITDAX (ex WES Distributions)	$2,052,000	$2,340,000	$2,612,000	$2,859,000	$9,863,000	$2,158,745	$1,210,402	$1,646,573	$1,651,762	$6,667,482	$6,752,291
CAPEX	$1,259,000	$1,211,000	$1,570,000	$2,171,000	$6,211,000	$1,003,827	$974,266	$866,915	$778,674	$3,623,682	$3,653,931

Source: SFG Estimates

Exhibit 19: PE Income Statement

Parsley Energy	2018	1Q '19	2Q '19	3Q '19	4Q '19	2019	1Q '20E	2Q '20E	3Q '20E	4Q '20E	2020E	1Q '21E	2Q '21E	3Q '21E	4Q '21E	2021E
Commodity Prices																
Crude Oil (Spot WTI - $/bbl)	$64.81	$54.72	$59.90	$56.41	$56.94	$56.99	$48.00	$30.00	$35.00	$35.00	$37.00	$40.00	$40.00	$40.00	$40.00	$40.00
Nat Gas (HH Spot - $/MMbtu)	$3.09	$3.17	$2.65	$2.25	$2.50	$2.64	$1.95	$2.00	$2.20	$2.50	$2.16	$2.60	$2.25	$2.50	$2.65	$2.50
Realized Crude Oil - $/bbl	$58.14	$49.40	$55.42	$54.12	$55.05	$53.50	$50.22	$42.80	$41.34	$41.45	$43.95	$42.30	$42.21	$39.30	$39.30	$40.78
Realized Nat Gas - $/MMbtu	$1.44	$1.33	$0.28	$0.64	$0.99	$0.81	$0.21	$0.61	$0.95	$0.99	$0.69	$1.00	$0.75	$1.65	$1.65	$1.26
Daily Production																
Crude - bls/d	69,468	78,911	86,604	91,739	89,576	86,751	127,400	130,800	128,500	126,500	128,296	126,700	128,400	128,500	128,800	128,107
NGL - bls/d	22,885	27,067	29,681	32,424	31,326	30,142	39,900	40,400	39,600	39,000	39,723	39,000	39,600	39,500	39,600	39,427
Nat Gas - Mcf/d	102,370	116,533	142,901	157,337	151,804	142,282	186,100	188,300	188,200	185,500	187,024	184,400	187,100	187,000	187,100	186,409
Equivalent - boe/d	109,415	125,400	140,103	150,386	146,203	140,607	198,317	202,583	199,467	196,417	199,189	196,433	199,183	199,167	199,583	198,602
Income Statement																
Revenues:																
Oil Sales	$1,536,244	$368,126	$458,888	$465,549	$464,752	$1,757,315	$557,439	$347,562	$406,066	$399,700	$1,710,767	$449,267	$460,408	$465,833	$466,931	$1,842,440
NGL & Natural Gas Sales	$278,503	$58,237	$38,453	$41,607	$54,365	$192,662	$48,367	$43,507	$53,228	$59,068	$204,170	$54,336	$48,932	$64,855	$67,573	$235,696
Total revenues	1,814,747	$426,363	$497,341	$507,156	$519,117	1,949,977	$605,806	$391,068	$459,294	$458,768	1,914,937	$503,603	$509,341	$530,688	$534,504	2,078,136
Costs & expenses:																
Lease operating expenses	$144,292	$41,172	$42,696	$45,719	$47,561	$177,148	$67,676	$69,132	$68,816	$67,764	$273,387	$63,644	$65,252	$64,132	$64,266	$257,294
Transportation expense	$32,573	$8,257	$6,608	$12,052	$14,281	$41,198	$9,673	$12,182	$11,710	$11,814	$45,379	$9,780	$10,765	$11,674	$11,487	$43,707
Production and ad valorem taxes	$108,342	$27,407	$30,744	$38,235	$28,575	$124,961	$39,377	$25,419	$29,854	$29,820	$124,471	$32,734	$33,107	$34,495	$34,743	$135,079
Depreciation, depletion and amortization	$586,279	$174,068	$198,916	$212,110	$211,111	$796,205	$275,214	$281,135	$279,852	$275,573	$1,111,773	$269,605	$276,417	$279,431	$280,015	$1,105,468
General and administrative (ex stock-base	$131,078	$32,715	$29,931	$31,543	$37,829	$132,018	$40,901	$41,000	$37,000	$39,000	$157,901	$33,000	$33,000	$33,000	$40,000	$139,000
Stock-based compensation	$19,877	$5,322	$4,976	$5,175	$5,209	$20,682	$8,170	$7,500	$6,500	$6,000	$28,170	$6,000	$6,000	$6,000	$6,000	$24,000
Exploration costs	$162,539	$22,994	$72	$11,988	$65,157	$100,211	$5,000	$5,000	$5,000	$5,000	$20,000	$5,000	$5,000	$5,000	$5,000	$20,000
Other operating expenses	$20,030	($811)	$3,761	$2,175	$26,091	$31,216	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total operating expense	$1,205,010	$311,124	$317,704	$358,997	$435,814	$1,423,639	$446,012	$441,368	$438,732	$434,970	$1,761,082	$419,764	$429,541	$433,731	$441,512	$1,724,548
Operating Income	$609,737	$115,239	$179,637	$148,159	$83,303	$526,338	$159,794	($50,300)	$20,562	$23,798	$153,855	$83,839	$79,799	$96,957	$92,993	$353,588
Other expense (income):																
Interest Expense, net	($126,596)	($32,711)	($33,494)	($33,578)	($33,463)	($133,246)	($39,071)	($34,882)	($42,837)	($34,468)	($151,258)	($42,588)	($34,269)	($42,490)	($34,223)	($153,570)
Unrealized derivative gain (loss)	$113,824	($101,832)	$38,248	$64,631	($76,775)	($75,728)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Realized derivative gain (loss)	($63,482)	($17,855)	($18,687)	($8,079)	($10,863)	($55,484)	$24,756	$161,389	$80,882	$80,262	$347,288	$33,069	$32,796	($1,254)	($1,254)	$63,356
Other income (expense)	$17,961	$1,366	$1,915	$3,420	$3,274	$9,975	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total other expense (income)	(58,293)	(151,032)	(12,018)	26,394	(117,827)	(254,483)	(14,314)	126,507	38,044	45,793	196,030	(9,519)	(1,473)	(43,744)	(35,477)	(90,213)
Pre-tax income	**$551,444**	**($35,793)**	**$167,619**	**$174,553**	**($34,524)**	**$271,855**	**$145,480**	**$76,207**	**$58,607**	**$69,591**	**$349,885**	**$74,320**	**$78,326**	**$53,213**	**$57,515**	**$263,375**
Income taxes:																
Current	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deferred	105,475	(7,790)	32,625	34,953	1,649	61,437	30,551	16,004	12,307	14,614	73,476	15,607	16,449	11,175	12,078	55,309
Total income taxes	$105,475	($7,790)	$32,625	$34,953	$1,649	$61,437	$30,551	$16,004	$12,307	$14,614	$73,476	$15,607	$16,449	$11,175	$12,078	$55,309
Reported Net Income	$445,969	($28,003)	$134,994	$139,600	($36,173)	$210,418	$114,929	$60,204	$46,299	$54,977	$276,409	$58,713	$61,878	$42,038	$45,437	$208,066
Less: Net income attributable to noncontrolling	($76,842)	$3,939	($19,059)	($19,890)	($196)	($35,206)	($11,493)	($5,719)	($4,398)	($5,223)	($26,834)	($5,578)	($5,878)	($3,994)	($4,317)	($19,766)
Net Income	**$369,127**	**($24,064)**	**$115,935**	**$119,710**	**($36,369)**	**$175,212**	**$103,436**	**$54,484**	**$41,901**	**$49,754**	**$249,576**	**$53,135**	**$55,999**	**$38,045**	**$41,121**	**$188,300**
Special items, net of taxes	27,045	86,373	(25,489)	(37,749)	115,879	139,014	-	-	-	-	-	-	-	-	-	-
Net Income after special items	**$396,172**	**$62,309**	**$90,446**	**$81,961**	**$79,510**	**$314,226**	**$103,436**	**$54,484**	**$41,901**	**$49,754**	**$249,576**	**$53,135**	**$55,999**	**$38,045**	**$41,121**	**$188,300**
Reported EPS - Diluted	$1.45	($0.09)	$0.41	$0.43	($0.13)	$0.63	$0.28	$0.15	$0.11	$0.13	$0.67	$0.14	$0.15	$0.10	$0.11	$0.50
Recurring EPS - Diluted	**$1.45**	**$0.22**	**$0.32**	**$0.29**	**$0.28**	**$1.12**	**$0.28**	**$0.15**	**$0.11**	**$0.13**	**$0.67**	**$0.14**	**$0.15**	**$0.10**	**$0.11**	**$0.50**
Basic shares outstanding	272,163	278,794	279,706	279,961	280,064	279,636	365,091	375,588	375,588	375,588	372,978	375,588	375,588	375,588	375,588	375,588
Diluted shares outstanding	272,918	278,794	279,768	280,547	280,064	279,799	365,091	375,588	375,588	375,588	372,978	375,588	375,588	375,588	375,588	375,588
Discretionary Cashflow (DCF):																
Net Income	$445,969	($28,003)	$134,994	$139,600	($36,173)	$210,418	$114,929	$60,204	$46,299	$54,977	$276,409	$58,713	$61,878	$42,038	$45,437	$208,066
DD&A	584,857	173,723	198,563	211,737	210,717	794,740	275,214	281,135	279,852	275,573	1,111,773	269,605	276,417	279,431	280,015	1,105,468
Exploration	162,539	22,994	72	11,988	65,157	100,211	5,000	5,000	5,000	5,000	20,000	5,000	5,000	5,000	5,000	20,000
Deferred taxes	105,475	(7,790)	32,625	34,953	1,649	61,437	30,551	16,004	12,307	14,614	73,476	15,607	16,449	11,175	12,078	55,309
Stock-based compensation	19,877	5,322	4,976	5,175	5,209	20,682	8,170	7,500	6,500	6,000	28,170	6,000	6,000	6,000	6,000	24,000
Unrealized derivative loss (gain)	(113,824)	101,832	(38,248)	(64,631)	76,775	75,728	0	0	0	0	0	0	0	0	0	0
Other	23,579	2,939	(3,673)	290	7,076	6,632	0	0	0	0	0	0	0	0	0	0
Discretionary cash flow (DCF)	$1,228,472	$271,017	$329,309	$339,112	$330,410	$1,269,848	$433,864	$369,842	$349,958	$356,164	$1,509,829	$354,925	$365,743	$343,644	$348,531	$1,412,842
Diluted DCFPS	**$4.50**	**$0.97**	**$1.18**	**$1.21**	**$1.18**	**$4.54**	**$1.19**	**$0.98**	**$0.93**	**$0.95**	**$4.05**	**$0.94**	**$0.97**	**$0.91**	**$0.93**	**$3.76**
Margin Analysis ($/boe):																
E&P Revenue	$45.44	$37.78	$39.01	$36.66	$38.59	$38.00	$33.57	$21.21	$25.03	$25.39	$26.27	$28.49	$28.10	$28.96	$29.11	$28.67
Production Expense	3.61	$3.65	$3.35	$3.30	$3.54	3.45	$3.75	$3.75	$3.75	$3.75	3.75	$3.60	$3.60	$3.50	$3.50	3.55
Transportation Expense	0.82	$0.73	$0.52	$0.87	$1.06	0.80	$0.28	$0.66	$0.64	$0.65	0.62	$0.55	$0.59	$0.64	$0.63	0.60
DD&A	14.64	$15.39	$15.57	$15.30	$15.67	15.49	$15.25	$15.25	$15.25	$15.25	15.25	$15.25	$15.25	$15.25	$15.25	15.25
G&A	3.28	2.90	2.35	2.28	2.81	2.57	2.27	2.22	2.02	2.16	2.17	1.87	1.82	1.80	2.18	1.92
Interest	3.17	2.90	2.63	2.43	2.49	2.60	2.16	1.89	2.33	1.91	2.07	2.41	1.89	2.32	1.86	2.12
Cash taxes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Discretionary cash flow	30.76	24.01	25.83	24.51	24.56	24.74	24.04	20.06	19.07	19.71	20.71	20.08	20.18	18.75	18.98	19.49
EBITDAX	$1,326,954	$301,134	$368,391	$370,670	$380,294	$1,420,489	$472,935	$404,724	$392,796	$390,632	$1,661,087	$397,512	$400,012	$386,134	$382,754	$1,566,412

Source: SFG Estimates

Exhibit 20: PXD Income Statement

Pioneer Natural Resources	2018	1Q '19	2Q '19	3Q '19	4Q '19	2019	1Q '20E	2Q '20E	3Q '20E	4Q '20E	2020E	1Q '21E	2Q '21E	3Q '21E	4Q '21E	2021E
Commodity Prices																
Benchmark Crude Oil (Spot WTI - $/bbl)	$64.81	$54.72	$59.90	$56.41	$56.94	$56.99	$48.00	$30.00	$35.00	$35.00	$37.00	$40.00	$40.00	$40.00	$40.00	$40.00
Benchmark Nat Gas (HH Spot - $/mmbtu)	$3.11	$3.17	$2.65	$2.25	$2.50	$2.64	$1.95	$2.00	$2.20	$2.50	$2.16	$2.60	$2.25	$2.50	$2.65	$2.50
Daily Production																
Crude - bls/d	190,639	206,256	207,438	215,204	220,326	212,352	223,500	225,200	225,300	222,450	224,111	222,700	225,100	227,350	225,200	225,101
NGL - bls/d	63,779	67,070	67,076	74,814	80,159	72,323	77,600	78,150	77,550	76,600	77,473	76,650	77,500	78,300	77,550	77,505
Nat Gas - mcf/d	393,392	360,620	357,917	364,240	377,268	365,055	410,100	413,200	398,900	393,800	403,958	394,300	398,600	402,600	398,800	398,598
Equivalent - boe/d	319,983	333,429	334,167	350,725	363,363	345,517	369,450	372,217	369,333	364,683	368,910	365,067	369,033	372,750	369,217	369,038
Income Statement																
(figures in $000s, except per share)																
Revenues:																
Oil and Gas sales	4,991,000	1,135,000	1,196,000	1,235,000	1,349,000	4,915,000	1,158,024	754,970	886,353	894,936	3,694,282	981,383	983,112	1,014,885	1,017,636	3,997,016
Marketing	458,000	152,000	81,000	46,000	4,000	283,000	(9,864)	(13,329)	(15,497)	(15,497)	(54,187)	(17,138)	(17,328)	(17,518)	(17,518)	(69,502)
Other	37,000	191,000	(11,000)	(222,000)	118,000	76,000	-	-	-	-	-	-	-	-	-	-
Total revenues	$5,486,000	$1,478,000	$1,266,000	$1,059,000	$1,471,000	$5,274,000	$1,148,160	$741,640	$870,856	$879,439	$3,640,095	$964,246	$965,784	$997,366	$1,000,118	$3,927,514
Costs & expenses:																
Lease operating	855,000	221,000	219,000	227,000	207,000	874,000	226,935	220,166	220,861	218,081	886,043	213,564	218,283	222,905	220,792	875,543
Production taxes	284,000	68,000	69,000	86,000	76,000	299,000	69,481	45,298	53,181	53,696	221,657	58,883	58,987	60,893	61,058	239,821
Exploration & abandonment	115,000	20,000	15,000	11,000	11,000	57,000	17,000	17,000	17,000	17,000	68,000	17,000	17,000	17,000	17,000	68,000
DD&A	1,533,000	421,000	412,000	438,000	440,000	1,711,000	453,869	457,268	458,712	452,937	1,822,786	443,556	453,357	462,956	458,567	1,818,436
ARO	14,000	3,000	2,000	2,000	3,000	10,000	2,500	2,500	2,500	2,500	10,000	2,500	2,500	2,500	2,500	10,000
G&A	290,000	70,000	64,000	53,000	59,000	246,000	57,000	57,000	58,000	60,000	232,000	56,000	57,000	57,000	62,000	232,000
Stock-based compensation	90,000	24,000	16,000	19,000	19,000	78,000	18,000	16,000	16,000	18,000	68,000	15,000	15,000	16,000	18,000	64,000
Impairment	77,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total operating expense	$3,258,000	$827,000	$797,000	$836,000	$815,000	$3,275,000	$844,785	$815,233	$826,255	$822,213	$3,308,486	$806,503	$822,127	$839,253	$839,917	$3,307,800
Operating Income	$2,228,000	$651,000	$469,000	$223,000	$656,000	$1,999,000	$303,375	($73,592)	$44,602	$57,225	$331,609	$157,743	$143,656	$158,113	$160,201	$619,713
Other expense (income):																
Other expense (income)	(127,000)	(29,000)	(29,000)	(29,000)	(34,000)	(121,000)	(21,863)	(19,050)	(19,050)	(19,050)	(79,013)	(17,976)	(18,576)	(18,801)	(18,750)	(74,102)
Realized commodity hedge gain (loss)	13,000	4,000	6,000	24,000	(106,000)	(72,000)	112,775	101,905	88,748	89,459	392,887	4,996	5,107	4,959	4,959	20,021
Unrealized derivative gains (loss)	(305,000)	(17,000)	37,000	97,000	(10,000)	107,000	0	0	0	0	0	0	0	0	0	0
Gain on asset sales	290,000	(9,000)	(488,000)	20,000	0	(477,000)	0	0	0	0	0	0	0	0	0	0
Other income (expense)	(845,000)	(147,000)	(211,000)	(32,000)	(58,000)	(448,000)	(25,000)	(20,000)	(20,000)	(15,000)	(80,000)	(15,000)	(15,000)	(15,000)	(15,000)	(60,000)
Total other income (expense)	(974,000)	(198,000)	(685,000)	80,000	(208,000)	(1,011,000)	65,913	62,855	49,698	55,409	233,875	(27,980)	(28,469)	(28,841)	(28,790)	(114,081)
Pre-tax income	**$1,254,000**	**$453,000**	**($216,000)**	**$303,000**	**$448,000**	**$988,000**	**$369,288**	**($10,737)**	**$94,299**	**$112,634**	**$565,484**	**$129,762**	**$115,187**	**$129,272**	**$131,411**	**$505,632**
Income taxes:																
Current	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deferred	275,000	103,000	(47,000)	72,000	104,000	232,000	84,936	(2,469)	21,689	25,906	130,061	29,845	26,493	29,732	30,224	116,295
Total income taxes	$275,000	$103,000	($47,000)	$72,000	$104,000	$232,000	$84,936	($2,469)	$21,689	$25,906	$130,061	$29,845	$26,493	$29,732	$30,224	$116,295
Net Income	$979,000	$350,000	($169,000)	$231,000	$344,000	$756,000	$284,351	($8,267)	$72,611	$86,728	$435,423	$99,917	$88,694	$99,539	$101,186	$389,337
Special items, net of taxes	105,000	(40,000)	509,000	101,000	51,000	621,000	-	-	-	-	-	-	-	-	-	-
Net Income after special items	**$1,084,000**	**$310,000**	**$340,000**	**$332,000**	**$395,000**	**$1,377,000**	**$284,351**	**($8,267)**	**$72,611**	**$86,728**	**$435,423**	**$99,917**	**$88,694**	**$99,539**	**$101,186**	**$389,337**
Reported EPS - Diluted	$5.73	$2.07	($1.01)	$1.38	$2.07	$4.51	$1.72	($0.05)	$0.44	$0.52	$2.63	$0.60	$0.54	$0.60	$0.61	$2.35
Recurring EPS - Diluted	**$6.34**	**$1.83**	**$2.01**	**$1.99**	**$2.36**	**$8.19**	**$1.72**	**($0.05)**	**$0.44**	**$0.52**	**$2.63**	**$0.60**	**$0.54**	**$0.60**	**$0.61**	**$2.35**
Basic shares outstanding	170,500	169,000	168,000	167,000	166,000	167,500	165,547	165,547	165,547	165,547	165,547	165,547	165,547	165,547	165,547	165,547
Diluted shares outstanding	171,000	169,000	168,000	167,000	166,000	167,500	165,547	165,547	165,547	165,547	165,547	165,547	165,547	165,547	165,547	165,547
Discretionary Cashflow (DCF):																
Net Income	$979,000	$350,000	($169,000)	$231,000	$344,000	$756,000	$284,351	($8,267)	$72,611	$86,728	$435,423	$99,917	$88,694	$99,539	$101,186	$389,337
DD&A	$1,533,000	421,000	412,000	438,000	440,000	$1,711,000	453,869	457,268	458,712	452,937	$1,822,786	443,556	453,357	462,956	458,567	$1,818,436
Exploration & dryhole	$115,000	20,000	15,000	11,000	11,000	$57,000	17,000	17,000	17,000	17,000	$68,000	17,000	17,000	17,000	17,000	$68,000
Deferred taxes	$275,000	103,000	(47,000)	72,000	104,000	$232,000	84,936	(2,469)	21,689	25,906	$130,061	29,845	26,493	29,732	30,224	$116,295
Other	$239,000	(26,000)	524,000	169,000	120,000	$787,000	20,500	18,500	18,500	20,500	$78,000	17,500	17,500	18,500	20,500	$74,000
Discretionary cash flow (DCF)	$3,141,000	$868,000	$735,000	$921,000	$1,019,000	$3,543,000	$860,657	$482,032	$588,511	$603,070	$2,534,270	$607,818	$603,045	$627,727	$627,478	$2,466,068
Diluted DCFPS	**$18.37**	**$5.14**	**$4.38**	**$5.51**	**$6.14**	**$21.15**	**$5.20**	**$2.91**	**$3.55**	**$3.64**	**$15.31**	**$3.67**	**$3.64**	**$3.79**	**$3.79**	**$14.90**
Margin Analysis ($/boe):																
E&P Revenue	$42.84	$37.96	$39.53	$39.02	$37.18	$38.40	$37.80	$25.30	$28.70	$29.34	$30.27	$30.02	$29.43	$29.74	$30.10	$29.82
Lease operating costs	$7.32	$7.36	$7.20	$7.04	$6.19	$6.93	$6.75	$6.50	$6.50	$6.50	$6.56	$6.50	$6.50	$6.50	$6.50	$6.50
Production taxes	$2.43	$2.27	$2.27	$2.67	$2.27	$2.37	$2.07	$1.34	$1.57	$1.60	$1.64	$1.79	$1.76	$1.78	$1.80	$1.78
Production taxes (% of pre-hedge rev)	5.6%	6.0%	5.8%	7.0%	5.6%	6.1%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
DD&A	$13.13	$14.03	$13.55	$13.57	$13.16	$13.57	$13.50	$13.50	$13.50	$13.50	$13.50	$13.50	$13.50	$13.50	$13.50	$13.50
G&A	$2.48	$2.33	$2.10	$1.64	$1.76	$1.95	$1.70	$1.68	$1.71	$1.79	$1.72	$1.70	$1.70	$1.66	$1.83	$1.72
Interest	$1.09	$0.97	$0.95	$0.90	$1.02	$0.96	$0.65	$0.56	$0.56	$0.57	$0.59	$0.55	$0.55	$0.55	$0.55	$0.55
Cash taxes	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Discretionary cash flow	$26.89	$28.93	$24.17	$28.54	$30.48	$28.09	$25.60	$14.23	$17.32	$17.97	$18.77	$18.50	$17.96	$18.30	$18.47	$18.31
EBITDAX	$3,308,000	$896,000	$774,000	$949,000	$1,043,000	$3,662,000	$907,519	$521,082	$627,561	$637,120	$2,693,283	$640,794	$636,621	$661,528	$661,227	$2,600,170

Source: SFG Estimates

Exhibit 21: RRC Income Statement

Range Resources	2018	1Q '19	2Q '19	3Q '19	4Q '19	2019	1Q '20E	2Q '20E	3Q '20E	4Q '20E	2020E	1Q '21E	2Q '21E	3Q '21E	4Q '21E	2021E
Commodity Prices																
Benchmark Crude Oil (Spot WTI - $/bbl)	$64.81	$54.72	$59.90	$56.41	$56.94	$56.99	$48.00	$30.00	$35.00	$35.00	$37.00	$40.00	$40.00	$40.00	$40.00	$40.00
Benchmark Nat Gas (HH Spot - $/mmbtu)	$3.11	$3.17	$2.65	$2.25	$2.50	$2.64	$1.95	$2.00	$2.20	$2.50	$2.16	$2.60	$2.25	$2.50	$2.65	$2.50
Crude Oil - $/bbl	$51.60	$49.61	$51.02	$49.73	$48.53	$49.73	$50.31	$49.18	$48.28	$41.94	$47.42	$36.38	$36.34	$36.32	$36.31	$36.34
NGL - $/bbl	$22.62	$23.17	$18.58	$15.80	$17.85	$18.85	$16.32	$12.18	$12.64	$14.56	$13.92	$14.19	$13.80	$13.40	$14.45	$13.96
Nat Gas - $/mmbtu	$2.98	$3.09	$2.54	$2.49	$2.47	$2.64	$2.33	$2.20	$2.21	$2.33	$2.27	$2.47	$2.04	$2.20	$2.38	$2.27
Daily Production																
Crude - bls/d	11,585	8,951	10,795	10,212	10,461	10,109	10,800	10,900	10,900	10,800	10,850	10,400	10,600	10,700	10,800	10,626
NGL - bls/d	105,001	106,806	108,212	103,383	107,381	106,439	113,100	114,600	114,700	114,700	114,277	114,100	117,000	118,100	119,200	117,117
Nat Gas - mcf/d	1,501,646	1,561,000	1,573,000	1,562,188	1,638,135	1,583,733	1,547,000	1,556,000	1,548,000	1,542,000	1,548,232	1,528,000	1,557,000	1,565,000	1,572,000	1,555,647
Equivalent - mcfe/d	2,201,159	2,255,542	2,287,042	2,243,758	2,345,187	2,283,021	2,290,400	2,309,000	2,301,600	2,295,000	2,298,996	2,275,000	2,322,600	2,337,800	2,352,000	2,322,105
Income Statement																
(data in thousands; except per share)																
Revenues:																
Oil & natural gas	$2,851,077	$671,654	$563,579	$474,754	$545,438	$2,255,425	$467,326	$407,594	$439,455	$502,834	$1,817,209	$518,089	$467,497	$496,755	$538,133	$2,020,474
Mark-to-Market of derivatives, net	(51,192)	(61,731)	195,245	74,676	18,491	226,681	77,798	80,064	57,130	23,321	238,312	1,456	3,049	1,932	1,242	7,679
Other	(12,551)	6,223	(8,624)	(6,651)	(4,675)	(13,727)	(4,000)	(4,000)	(4,000)	(4,000)	(16,000)	-	-	-	-	-
Total revenues	$2,787,334	$616,146	$750,200	$542,779	$559,254	$2,468,379	$541,123	$483,658	$492,585	$522,155	$2,039,521	$519,545	$470,545	$498,687	$539,375	$2,028,153
Costs & expenses:																
Production costs	$183,571	$43,946	$43,321	$42,762	$42,286	$172,315	$40,610	$38,855	$38,354	$39,214	$157,032	$35,918	$36,135	$37,065	$37,828	$146,946
Transportation, gathering, and compressio	$1,117,816	$302,655	$301,219	$295,912	$299,511	$1,199,297	$302,218	$298,369	$296,446	$295,596	$1,192,629	$282,555	$289,559	$294,656	$294,282	$1,161,052
Exploration	32,196	7,838	7,721	10,517	9,156	35,232	8,000	8,000	8,000	8,000	32,000	5,000	5,000	5,000	5,000	20,000
DD&A	635,467	138,718	141,505	137,751	130,869	548,843	104,213	105,060	105,874	105,570	420,716	102,375	105,678	107,539	108,192	423,784
G&A	152,040	37,117	38,505	32,626	30,269	138,517	33,000	32,000	32,000	36,000	133,000	32,000	32,000	32,000	36,000	132,000
Stock-based compensation	71,127	10,164	2,474	9,760	15,466	37,864	0	0	0	0	0	0	0	0	0	0
Other	(25,316)	4,287	2,206	(8,053)	1,954	394	0	0	0	0	0	0	0	0	0	0
Total operating expense	$4,345,706	$557,384	$549,721	$537,477	$2,818,856	$4,463,438	$488,042	$482,283	$480,674	$484,380	$1,935,378	$457,848	$468,372	$476,261	$481,302	$1,883,782
Operating Income	($1,558,372)	$58,762	$200,479	$5,302	($2,259,602)	($1,995,059)	$53,081	$1,375	$11,911	$37,776	$104,143	$61,697	$2,173	$22,427	$58,073	$144,370
Other expense (income):																
Interest Expense	(208,471)	(51,537)	(51,727)	(46,997)	(44,024)	(194,285)	(51,962)	(47,220)	(47,958)	(48,264)	(195,405)	(48,287)	(48,708)	(49,528)	(49,907)	(196,430)
Other expense (income)	(10,127)	(118)	6,532	(33,105)	(553)	(27,244)	0	0	0	0	0	0	0	0	0	0
Total other expense (income)	(218,598)	(51,655)	(45,195)	(80,102)	(44,577)	(221,529)	(51,962)	(47,220)	(47,958)	(48,264)	(195,405)	(48,287)	(48,708)	(49,528)	(49,907)	(196,430)
Pre-tax income	**($1,776,970)**	**$7,107**	**$155,284**	**($74,800)**	**($2,304,179)**	**($2,216,588)**	**$1,119**	**($45,845)**	**($36,047)**	**($10,489)**	**($91,262)**	**$13,410**	**($46,534)**	**($27,101)**	**$8,166**	**($52,060)**
Income taxes:																
Current	0	0	0	4,079	2,068	6,147	0	0	0	0	0	0	0	0	0	0
Deferred	(30,489)	5,688	40,099	(51,298)	(500,927)	(506,438)	280	(11,461)	(9,012)	(2,622)	(22,815)	3,352	(11,634)	(6,775)	2,041	(13,015)
Total income taxes	($30,489)	$5,688	$40,099	($47,219)	($498,859)	($500,291)	$280	($11,461)	($9,012)	($2,622)	($22,815)	$3,352	($11,634)	($6,775)	$2,041	($13,015)
Net Income	($1,746,481)	$1,419	$115,185	($27,581)	($1,805,320)	($1,716,297)	$839	($34,384)	($27,035)	($7,867)	($68,446)	$10,057	($34,901)	($20,326)	$6,124	($39,045)
Special items, net of taxes	2,025,912	89,292	(111,338)	9,963	1,826,018	1,813,935	-	-	-	-	-	-	-	-	-	-
Net Income after special items	**$279,431**	**$90,711**	**$3,847**	**($17,618)**	**$20,698**	**$97,638**	**$839**	**($34,384)**	**($27,035)**	**($7,867)**	**($68,446)**	**$10,057**	**($34,901)**	**($20,326)**	**$6,124**	**($39,045)**
Reported EPS - Diluted	($7.08)	$0.01	$0.46	($0.11)	($7.27)	($6.91)	$0.00	($0.14)	($0.11)	($0.03)	($0.28)	$0.04	($0.14)	($0.08)	$0.02	($0.16)
Recurring EPS - Diluted	**$1.13**	**$0.36**	**$0.02**	**($0.07)**	**$0.08**	**$0.39**	**$0.00**	**($0.14)**	**($0.11)**	**($0.03)**	**($0.28)**	**$0.04**	**($0.14)**	**($0.08)**	**$0.02**	**($0.16)**
Diluted shares outstanding	246,568	249,154	248,436	248,082	248,277	248,487	246,287	246,287	246,287	246,287	246,287	246,287	246,287	246,287	246,287	246,287
Discretionary cash flow (DCF)	$1,048,394	$269,315	$156,160	$127,791	$174,774	$728,040	$113,332	$67,214	$77,827	$103,081	$361,455	$120,785	$64,144	$85,437	$121,358	$391,724
Diluted DCFPS	**$4.25**	**$1.08**	**$0.63**	**$0.52**	**$0.70**	**$2.93**	**$0.46**	**$0.27**	**$0.32**	**$0.42**	**$1.47**	**$0.49**	**$0.26**	**$0.35**	**$0.49**	**$1.59**
Margin Analysis ($/mcfe):																
E&P Revenue, ex hedges	$3.55	$3.31	$2.71	$2.30	$3.37	$2.71	$2.24	$1.94	$2.08	$2.38	$2.16	$2.53	$2.21	$2.31	$2.49	$2.38
Production, gathering, and transport costs	1.62	1.71	1.66	1.64	1.77	1.65	1.64	1.60	1.58	1.59	1.60	1.56	1.54	1.54	1.53	1.54
DD&A	0.79	0.68	0.68	0.67	0.75	0.66	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
G&A	0.19	0.18	0.19	0.16	0.16	0.17	0.16	0.15	0.15	0.17	0.16	0.16	0.15	0.15	0.17	0.16
Interest	0.26	0.25	0.25	0.23	0.25	0.23	0.25	0.22	0.23	0.23	0.23	0.24	0.23	0.23	0.23	0.23
Cash taxes	0.00	0.00	0.00	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Discretionary cash flow	1.30	1.33	0.75	0.62	1.15	0.87	0.54	0.32	0.37	0.49	0.43	0.59	0.30	0.40	0.56	0.46
EBITDAX	$1,255,364	$319,064	$204,646	$177,213	$214,403	$915,326	$165,295	$114,434	$125,785	$151,346	$556,859	$169,072	$112,852	$134,966	$171,265	$588,154

Source: SFG Estimates

Exhibit 22: SM Income Statement

SM Energy	2018	1Q '19	2Q '19	3Q '19	4Q '19E	2019E	1Q '20E	2Q '20E	3Q '20E	4Q '20E	2020E	1Q '21E	2Q '21E	3Q '21E	4Q '21E	2021E
Commodity Prices																
Crude Oil (Spot WTI - $/bbl)	$64.81	$54.72	$59.90	$56.41	$56.94	$56.99	$48.00	$30.00	$35.00	$35.00	$37.00	$40.00	$40.00	$40.00	$40.00	$40.00
Nat Gas (HH Spot - $/mmbtu)	$3.11	$3.17	$2.65	$2.25	$2.50	$2.64	$1.95	$2.00	$2.20	$2.50	$2.16	$2.60	$2.25	$2.50	$2.65	$2.50
Crude Oil - $/bbl	$53.13	$49.19	$54.07	$53.57	$55.22	$53.19	$55.25	$50.84	$50.67	$52.74	$52.37	$42.65	$39.66	$39.65	$39.67	$40.42
Nat Gas - $/mmbtu	$3.31	$2.55	$2.51	$2.59	$2.75	$2.60	$2.23	$1.59	$1.88	$2.11	$1.95	$2.13	$1.84	$2.20	$2.30	$2.11
Daily Production																
Crude - bls/d	51,436	53,689	59,637	58,957	67,272	59,923	66,100	65,900	65,600	65,400	65,749	63,700	62,250	61,500	60,650	62,015
NGL - bls/d	21,866	20,800	25,077	22,467	20,533	22,219	18,950	17,450	16,050	14,800	16,805	13,600	12,550	11,600	10,750	12,116
Nat Gas - mcf/d	282,764	265,478	310,890	320,609	305,696	300,833	292,000	281,000	265,000	253,000	272,675	239,150	226,350	215,050	205,550	221,415
Equivalent - boe/d	722,573	712,411	819,176	809,152	832,522	793,688	802,300	781,100	754,900	734,200	767,996	702,950	675,150	653,650	633,950	666,201
Income Statement																
Revenues:																
Oil & gas sales	$1,636,357	$340,476	$406,854	$389,419	$449,001	$1,585,750	$356,116	$231,772	$269,997	$274,648	$1,132,532	$287,134	$275,118	$280,594	$276,831	$1,119,677
Other	3,798	393	-	898	2,146	3,437	-	-	-	-	-	-	-	-	-	-
Total revenues	1,640,155	340,869	406,854	390,317	451,147	1,589,187	356,116	231,772	269,997	274,648	1,132,532	287,134	275,118	280,594	276,831	1,119,677
Costs & expenses:																
Production costs	$295,911	$77,718	$73,323	$79,466	$83,100	$313,607	$79,436	$69,747	$70,985	$70,291	$290,460	$67,667	$66,267	$65,907	$64,666	$264,507
Transportation	$191,456	$43,587	$49,727	$49,576	$44,212	$187,102	$42,032	$38,672	$35,972	$33,097	$149,772	$29,789	$27,712	$25,918	$23,976	$107,395
DD&A	665,313	177,746	206,330	211,125	228,597	823,798	229,979	223,902	218,770	212,771	885,423	199,286	193,532	189,428	183,719	765,965
Exploration	55,166	11,348	10,877	11,626	17,649	51,500	12,500	12,500	12,500	12,500	50,000	12,500	12,500	12,500	12,500	50,000
G&A	116,504	32,086	30,920	32,578	37,213	132,797	30,000	31,000	31,000	33,000	125,000	29,000	29,000	29,000	33,000	120,000
Impairment	37,954	6,338	0	6,337	8,750	21,425	0	0	0	0	0	0	0	0	0	0
Other	30,263	335	11,483	1,021	19,466	32,305	0	0	0	0	0	0	0	0	0	0
Total operating expense	$1,392,567	$349,158	$382,660	$391,729	$438,987	$1,562,534	$393,947	$375,821	$369,227	$361,659	$1,500,654	$338,242	$329,011	$322,752	$317,861	$1,307,866
Operating Income	$247,588	($8,289)	$24,194	($1,412)	$12,160	$26,653	($37,831)	($144,049)	($99,230)	($87,011)	($368,122)	($51,109)	($53,893)	($42,158)	($41,030)	($188,189)
Other expense (income):																
Interest Expense	(160,906)	(37,980)	(39,627)	(40,584)	(40,911)	(159,102)	(38,642)	(38,575)	(38,571)	(38,433)	(154,221)	(38,446)	(38,605)	(38,602)	(38,518)	(154,171)
Net Profits Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Realized Derivative Gains (Losses)	(135,803)	(4,969)	4,090	24,722	15,379	39,222	63,806	133,393	100,125	110,457	407,781	17,602	585	(355)	(361)	17,470
Unrealized Derivative Gains (Losses)	297,635	(172,112)	75,565	76,167	(116,381)	(136,761)	0	0	0	0	0	0	0	0	0	0
Gain (loss) on asset sales	426,917	61	56	0	539	656	0	0	0	0	0	0	0	0	0	0
Other expense (income)	(23,654)	(317)	(300)	(548)	(547)	(1,712)	0	0	0	0	0	0	0	0	0	0
Total other expense (income)	404,189	(215,317)	39,784	59,757	(141,921)	(257,697)	25,164	94,818	61,554	72,023	253,561	(20,844)	(38,020)	(38,957)	(38,879)	(136,701)
Pre-tax income	**$651,777**	**($223,606)**	**$63,978**	**$58,345**	**($129,761)**	**($231,044)**	**($12,667)**	**($49,231)**	**($37,676)**	**($14,988)**	**($114,562)**	**($71,953)**	**($91,913)**	**($81,116)**	**($79,909)**	**($324,890)**
Income taxes:																
Current	992	0	0	0	(509)	(509)	0	0	0	0	0	0	0	0	0	0
Deferred	142,378	(46,038)	13,590	16,111	28,215	11,878	(2,660)	(10,339)	(7,912)	(3,147)	(24,058)	(15,830)	(20,221)	(17,845)	(17,580)	(71,476)
Total income taxes	$143,370	($46,038)	$13,590	$16,111	$27,706	$11,369	($2,660)	($10,339)	($7,912)	($3,147)	($24,058)	($15,830)	($20,221)	($17,845)	($17,580)	($71,476)
Reported Net Income	$508,407	($177,568)	$50,388	$42,234	($157,467)	($242,413)	($10,007)	($38,893)	($29,764)	($11,841)	($90,504)	($56,123)	($71,692)	($63,270)	($62,329)	($253,415)
Special items, net of taxes	(504,357)	139,845	(49,103)	(54,337)	152,461	188,866	-	-	-	-	-	-	-	-	-	-
Net Income after special items	**$4,050**	**($37,723)**	**$1,285**	**($12,103)**	**($5,006)**	**($53,547)**	**($10,007)**	**($38,893)**	**($29,764)**	**($11,841)**	**($90,504)**	**($56,123)**	**($71,692)**	**($63,270)**	**($62,329)**	**($253,415)**
Reported EPS - Diluted	$4.52	($1.58)	$0.45	$0.37	($1.40)	($2.15)	($0.09)	($0.34)	($0.26)	($0.10)	($0.80)	($0.50)	($0.64)	($0.56)	($0.55)	($2.25)
Recurring EPS - Diluted	**$0.04**	**($0.34)**	**$0.01**	**($0.11)**	**($0.04)**	**($0.47)**	**($0.09)**	**($0.34)**	**($0.26)**	**($0.10)**	**($0.80)**	**($0.50)**	**($0.64)**	**($0.56)**	**($0.55)**	**($2.25)**
Basic shares outstanding	111,779	112,252	112,262	112,804	112,847	112,541	112,847	112,847	112,847	112,847	112,847	112,847	112,847	112,847	112,847	112,847
Diluted shares outstanding	112,557	112,252	112,932	113,334	112,847	112,841	112,847	112,847	112,847	112,847	112,847	112,847	112,847	112,847	112,847	112,847
Discretionary Cashflow (DCF):																
Net Income	$508,407	($177,568)	$50,388	$42,234	($157,467)	($242,413)	($10,007)	($38,893)	($29,764)	($11,841)	($90,504)	($56,123)	($71,692)	($63,270)	($62,329)	($253,415)
DD&A	665,313	177,746	206,330	211,125	228,597	823,798	229,979	223,902	218,770	212,771	885,423	199,286	193,532	189,428	183,719	765,965
ARO	11,935	0	12,417	0	0	12,417	0	0	0	0	0	0	0	0	0	0
Exploration Expense	55,166	11,348	10,877	11,626	17,649	51,500	12,500	12,500	12,500	12,500	50,000	12,500	12,500	12,500	12,500	50,000
Deferred taxes	142,378	(46,038)	13,590	16,111	28,215	11,878	(2,660)	(10,339)	(7,912)	(3,147)	(24,058)	(15,830)	(20,221)	(17,845)	(17,580)	(71,476)
Impairment of O&G properties	37,954	6,338	0	6,337	8,750	21,425	0	0	0	0	0	0	0	0	0	0
Stock-based compensation	22,592	4,633	6,154	6,766	5,560	23,113	5,000	5,000	5,000	5,000	20,000	5,000	5,000	5,000	5,000	20,000
Unrealized Derivative (Gain) Loss	(297,635)	172,112	(75,565)	(76,167)	116,381	136,761	0	0	0	0	0	0	0	0	0	0
(Gain) Loss on Sale	(426,917)	(61)	(56)	0	(539)	(656)	0	0	0	0	0	0	0	0	0	0
Other	10,061	290	3,765	(5,203)	(10,236)	(11,384)	0	0	0	0	0	0	0	0	0	0
Discretionary cash flow (DCF)	$729,254	$148,800	$227,900	$212,829	$236,910	$826,439	$234,812	$192,171	$198,594	$215,283	$840,861	$144,833	$119,119	$125,812	$121,309	$511,074
Diluted DCFPS	**$6.50**	**$1.35**	**$2.00**	**$1.90**	**$2.10**	**$7.30**	**$2.10**	**$1.70**	**$1.75**	**$1.90**	**$7.45**	**$1.30**	**$1.05**	**$1.10**	**$1.05**	**$4.55**
Margin Analysis ($/mcfe):																
E&P Revenue	$5.69	$5.31	$5.46	$5.23	$5.86	$5.61	$4.88	$3.26	$3.89	$4.07	$5.48	$4.54	$4.48	$4.67	$4.75	$4.68
Production expense	1.12	1.21	0.98	1.07	1.08	1.08	1.09	0.98	1.02	1.04	1.03	1.07	1.08	1.10	1.11	1.09
DD&A	2.52	2.77	2.77	2.84	2.98	2.84	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15
G&A	0.36	0.43	0.33	0.35	0.41	0.38	0.34	0.37	0.37	0.41	0.37	0.38	0.39	0.40	0.48	0.41
Interest	0.61	0.59	0.53	0.55	0.53	0.55	0.53	0.54	0.56	0.57	0.55	0.61	0.63	0.64	0.66	0.63
Cash taxes	0.00	0.00	0.00	0.00	(0.01)	(0.00)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Discretionary cash flow	2.77	2.32	3.06	2.86	3.09	2.85	3.22	2.70	2.86	3.19	2.99	2.29	1.94	2.09	2.08	2.10
EBITDAX	$ 892,721	$ 186,807	$ 262,956	$ 257,765	$ 286,176	$ 993,704	$ 273,454	$ 230,746	$ 237,165	$ 253,716	$ 995,082	$ 183,280	$ 157,724	$ 164,414	$ 159,827	$ 665,246

Source: SFG Estimates

Exhibit 23: SWN Income Statement

Southwestern Energy	2018	1Q '19	2Q '19	3Q '19	4Q '19	2019	1Q '20E	2Q '20E	3Q '20E	4Q '20E	2020E	1Q '21E	2Q '21E	3Q '21E	4Q '21E	2021E
Benchmark Commodity Prices																
Crude Oil (Spot WTI - $/bbl)	$64.81	$54.72	$59.90	$56.41	$56.94	$56.99	$48.00	$30.00	$35.00	$35.00	$37.00	$40.00	$40.00	$40.00	$40.00	$40.00
Nat Gas (HH Spot - $/mmbtu)	$3.11	$3.17	$2.65	$2.25	$2.50	$2.64	$1.95	$2.00	$2.20	$2.50	$2.16	$2.60	$2.25	$2.50	$2.65	$2.50
Production																
Crude - bls/d	9,334	9,489	10,297	15,424	16,152	12,866	14,890	13,688	16,942	18,811	16,093	16,449	16,922	17,218	17,314	16,979
NGLs - bls/d	53,992	62,256	60,407	64,250	71,837	64,712	69,488	71,861	77,182	79,005	74,404	79,407	79,857	80,349	80,798	80,107
Nat Gas - mcf/d	2,210,959	1,588,889	1,626,374	1,717,391	1,739,130	1,668,493	1,706,308	1,711,846	1,846,830	1,855,375	1,780,478	1,841,440	1,858,553	1,921,432	1,890,975	1,878,355
Equivalent - mcfe/d	2,590,915	2,019,356	2,050,593	2,195,435	2,267,065	2,133,962	2,212,579	2,225,140	2,411,578	2,442,269	2,323,460	2,416,576	2,439,226	2,506,835	2,479,644	2,460,870
Income Statement																
Revenues:																
Oil & natural gas sales	$2,525,000	$542,000	$371,000	$348,000	$451,000	$1,712,000	$357,356	$289,706	$361,545	$422,766	$1,431,373	$457,995	$369,687	$422,752	$451,477	$1,701,912
Midstream & Other (net)	4,000	3,000	(8,000)	(8,000)	(5,000)	(18,000)	-	-	-	-	-	-	-	-	-	-
Total revenues	$2,529,000	$545,000	$363,000	$340,000	$446,000	$1,694,000	$357,356	$289,706	$361,545	$422,766	$1,431,373	$457,995	$369,687	$422,752	$451,477	$1,701,912
Costs & expenses:																
Production costs	$961,000	$185,000	$186,000	$203,000	$208,000	$782,000	$204,548	$197,184	$217,879	$222,748	$842,360	$217,763	$218,102	$228,409	$227,136	$891,410
G&A	202,000	34,000	35,000	39,000	47,000	155,000	33,000	33,000	33,000	40,000	139,000	38,000	38,000	38,000	43,000	157,000
DD&A	514,000	110,000	118,000	123,000	119,000	470,000	120,807	121,493	133,119	134,813	510,232	130,495	133,182	138,377	136,876	538,930
Total operating expense	$1,714,000	$332,000	$341,000	$369,000	$382,000	$1,424,000	$358,355	$351,677	$383,998	$397,561	$1,491,591	$386,258	$389,283	$404,786	$407,013	$1,587,341
Operating Income	$815,000	$213,000	$22,000	($29,000)	$64,000	$270,000	($999)	($61,971)	($22,453)	$25,205	($60,218)	$71,737	($19,596)	$17,966	$44,464	$114,571
Other income (expense):																
Interest expense	(124,000)	(14,000)	(15,000)	(17,000)	(19,000)	(65,000)	(21,568)	(17,555)	(18,289)	(23,489)	(80,901)	(23,501)	(24,053)	(25,021)	(25,517)	(98,093)
Derivatives inccome	(118,000)	(32,000)	152,000	100,000	54,000	274,000	87,948	108,292	84,609	48,440	329,290	11,853	30,450	14,200	11,478	67,980
Other	(35,000)	1,000	(6,000)	5,000	1,000	1,000	0	0	0	0	0	0	0	0	0	0
Total other income (expense)	(277,000)	(45,000)	131,000	88,000	36,000	210,000	66,380	90,737	66,320	24,951	248,389	(11,649)	6,397	(10,821)	(14,039)	(30,112)
Pre-tax income	**$538,000**	**$168,000**	**$153,000**	**$59,000**	**$100,000**	**$480,000**	**$65,381**	**$28,766**	**$43,867**	**$50,156**	**$188,171**	**$60,088**	**($13,200)**	**$7,145**	**$30,425**	**$84,459**
Current	1,000	0	0	(1,000)	(1,000)	(2,000)	0	0	0	0	0	0	0	0	0	0
Deferred	0	(426,000)	15,000	11,000	(9,000)	(409,000)	16,345	7,192	10,967	12,539	47,043	15,022	(3,300)	1,786	7,606	21,115
Total income taxes	$1,000	($426,000)	$15,000	$10,000	($10,000)	($411,000)	$16,345	$7,192	$10,967	$12,539	$47,043	$15,022	($3,300)	$1,786	$7,606	$21,115
Net Income	$534,000	$594,000	$138,000	$49,000	$110,000	$891,000	$49,036	$21,575	$32,900	$37,617	$141,128	$45,066	($9,900)	$5,359	$22,819	$63,344
Special items, net	55,000	(449,000)	(98,000)	(5,000)	(11,000)	(563,000)	-	-	-	-	-	-	-	-	-	-
Adjusted Net Income	**$589,000**	**$145,000**	**$40,000**	**$44,000**	**$99,000**	**$328,000**	**$49,036**	**$21,575**	**$32,900**	**$37,617**	**$141,128**	**$45,066**	**($9,900)**	**$5,359**	**$22,819**	**$63,344**
Adjusted EPS - Diluted	**$1.02**	**$0.27**	**$0.08**	**$0.08**	**$0.18**	**$0.61**	**$0.09**	**$0.04**	**$0.06**	**$0.07**	**$0.26**	**$0.08**	**($0.02)**	**$0.01**	**$0.04**	**$0.12**
Basic shares outstanding	574,623	539,722	539,006	539,221	539,435	539,346	539,435	539,435	539,435	539,435	539,435	539,435	539,435	539,435	539,435	539,435
Diluted shares outstanding	576,417	541,320	539,947	540,038	540,574	540,470	540,574	540,574	540,574	540,574	540,574	540,574	540,574	540,574	540,574	540,574
Discretionary Cashflow (DCF):																
Net Income	534,000	$594,000	$138,000	$49,000	$110,000	891,000	$49,036	$21,575	$32,900	$37,617	141,128	$45,066	($9,900)	$5,359	$22,819	63,344
DD&A	584,000	110,000	134,000	123,000	136,000	503,000	120,807	121,493	133,119	134,813	510,232	130,495	133,182	138,377	136,876	538,930
Deferred taxes	0	(426,000)	15,000	11,000	(9,000)	(409,000)	16,345	7,192	10,967	12,539	47,043	15,022	(3,300)	1,786	7,606	21,115
Other	234,000	31,000	(114,000)	2,000	9,000	(72,000)	3,000	3,000	3,000	5,000	14,000	8,000	8,000	8,000	8,000	32,000
Discretionary cash flow (DCF)	1,352,000	$309,000	$173,000	$185,000	$246,000	913,000	$189,188	$153,259	$179,986	$189,969	712,403	$198,583	$127,982	$153,523	$175,301	655,389
Diluted DCFPS	**$2.35**	**$0.57**	**$0.32**	**$0.34**	**$0.46**	**$1.69**	**$0.35**	**$0.28**	**$0.33**	**$0.35**	**$1.32**	**$0.37**	**$0.24**	**$0.28**	**$0.32**	**$1.21**
Margin Analysis ($/mcfe):																
E&P Revenue	$2.67	$2.98	$1.99	$1.72	$2.16	$2.20	$1.77	$1.43	$1.63	$1.88	$1.68	$2.11	$1.67	$1.83	$1.98	$1.89
Production costs	1.02	1.02	1.00	1.01	1.00	1.00	1.02	0.97	0.98	0.99	0.99	1.00	0.98	0.99	1.00	0.99
DD&A - oil + Gas	0.54	0.61	0.63	0.61	0.57	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
G&A	0.21	0.19	0.19	0.19	0.23	0.20	0.16	0.16	0.15	0.18	0.16	0.17	0.17	0.16	0.19	0.17
Interest	0.13	0.08	0.08	0.08	0.09	0.08	0.11	0.09	0.08	0.10	0.10	0.11	0.11	0.11	0.11	0.11
Cash taxes	0.00	0.00	0.00	(0.00)	(0.00)	(0.00)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Discretionary cash flow	1.43	1.70	0.93	0.92	1.18	1.17	0.94	0.76	0.81	0.85	0.84	0.91	0.58	0.67	0.77	0.73
Capital Expenditures	$1,263,000	$324,000	$368,000	$240,000	$207,000	$1,139,000	$258,000	$248,000	$212,000	$178,000	$896,000	$203,000	$234,000	$241,000	$187,000	$865,000
EBITDAX	$1,429,000	$319,000	$186,000	$202,000	$266,000	$879,000	$210,756	$170,814	$198,275	$213,458	$793,303	$222,085	$152,036	$178,544	$200,818	$753,482

Source: SFG Estimates

Exhibit 24: WPX Income Statement

WPX Energy	2018	1Q '19	2Q '19	3Q '19	4Q '19	2019	1Q '20E	2Q '20E	3Q '20E	4Q '20E	2020E	1Q '21E	2Q '21E	3Q '21E	4Q '21E	2021E
Commodity Prices																
Crude Oil (Spot WTI - $/bbl)	$64.81	$54.72	$59.90	$56.41	$56.94	$56.99	$48.00	$30.00	$35.00	$35.00	$37.00	$40.00	$40.00	$40.00	$40.00	$40.00
Nat Gas (HH Spot - $/mmbtu)	$3.11	$3.17	$2.65	$2.25	$2.50	$2.64	$1.95	$2.00	$2.20	$2.50	$2.16	$2.60	$2.25	$2.50	$2.65	$2.50
Crude Oil - $/bbl	$51.58	$51.96	$54.44	$52.67	$53.16	$53.06	$51.89	$46.89	$47.75	$47.51	$48.29	$37.73	$37.79	$37.84	$37.88	$37.81
Nat Gas - $/mmbtu	$1.97	$1.78	$1.76	$1.57	$1.54	$1.66	$1.08	$0.89	$0.90	$1.06	$0.98	$1.48	$1.28	$1.26	$1.37	$1.35
Daily Production																
Crude - bls/d	81,562	96,089	97,857	108,598	111,728	103,625	122,300	157,900	163,500	166,200	152,543	162,800	161,800	162,800	161,900	162,324
NGL - bls/d	18,444	25,422	27,396	27,022	30,174	27,515	31,450	39,850	41,900	43,600	39,219	43,900	44,100	44,650	44,750	44,353
Nat Gas - mcf/d	162,644	202,333	205,890	226,891	223,185	214,666	231,700	285,400	300,800	314,700	283,284	316,300	318,000	323,600	325,100	320,782
Equivalent - boe/d	127,113	155,233	159,568	173,435	179,100	166,917	192,367	245,317	255,533	262,250	238,976	259,417	258,900	261,383	260,833	260,141
Income Statement																
Revenues:																
Oil & gas sales	$2,025,000	$507,000	$558,000	$581,000	$601,000	$2,247,000	$560,759	$449,516	$551,339	$568,210	$2,129,824	$628,473	$628,131	$644,119	$647,085	$2,547,808
Other	$21,000	10,000	17,000	2,000	4,000	$33,000	-	-	-	-	$0	-	-	-	-	$0
Total revenues	2,046,000	517,000	$575,000	$583,000	$605,000	2,280,000	560,759	$449,516	$551,339	$568,210	2,129,824	628,473	$628,131	$644,119	$647,085	2,547,808
Costs & expenses:																
Production costs	$536,000	$167,000	$177,000	$191,000	$200,000	$735,000	$212,101	$243,324	$255,229	$257,058	$967,712	$250,229	$252,000	$257,443	$256,997	$1,016,668
DD&A	$777,000	219,000	221,000	241,000	247,000	$928,000	280,086	357,181	376,145	386,032	$1,399,444	373,560	376,958	384,756	383,947	$1,519,221
G&A	$182,000	47,000	48,000	51,000	60,000	$206,000	47,000	54,000	53,000	55,000	$209,000	50,000	50,000	50,000	53,000	$203,000
Impairment	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0
Other	$81,000	26,000	27,000	34,000	29,000	$116,000	20,000	20,000	20,000	20,000	$80,000	20,000	20,000	20,000	20,000	$80,000
Total operating expense	$1,576,000	$459,000	$473,000	$517,000	$536,000	$1,985,000	$559,187	$674,505	$704,374	$718,090	$2,656,156	$693,789	$698,958	$712,199	$713,943	$2,818,890
Operating Income	$470,000	$58,000	$102,000	$66,000	$69,000	$295,000	$1,572	($224,989)	($153,035)	($149,880)	($526,332)	($65,316)	($70,828)	($68,080)	($66,858)	($271,082)
Other expense (income):																
Interest Expense	(163,000)	(41,000)	(40,000)	(38,000)	(40,000)	(159,000)	(38,129)	(48,254)	(48,254)	(48,254)	(182,890)	(48,254)	(48,254)	(48,254)	(48,254)	(193,015)
Other expense (income)	9,000	(79,000)	327,000	133,000	(189,000)	192,000	71,611	278,238	226,977	228,081	804,907	6,161	5,592	1,467	2,433	15,653
Total other expense (income)	(154,000)	(120,000)	287,000	95,000	(229,000)	33,000	33,482	229,984	178,723	179,827	622,017	(42,093)	(42,662)	(46,786)	(45,820)	(177,362)
Pre-tax income	**$316,000**	**($62,000)**	**$389,000**	**$161,000**	**($160,000)**	**$328,000**	**$35,054**	**$4,995**	**$25,688**	**$29,948**	**$95,685**	**($107,409)**	**($113,489)**	**($114,866)**	**($112,678)**	**($448,444)**
Income taxes:																
Current	0	0	0	0	(19,000)	(19,000)	0	0	0	0	0	0	0	0	0	0
Deferred	74,000	(14,000)	84,000	39,000	(20,000)	89,000	8,062	1,149	5,908	6,888	22,008	(24,704)	(26,103)	(26,419)	(25,916)	(103,142)
Total income taxes	$74,000	($14,000)	$84,000	$39,000	($39,000)	$70,000	$8,062	$1,149	$5,908	$6,888	$22,008	($24,704)	($26,103)	($26,419)	($25,916)	($103,142)
Preferred dividends	(8,000)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Discontinued ops	(91,000)	-	-	(1,000)	(1,000)	(2,000)	-	-	-	-	-	-	-	-	-	-
Reported Net Income	$143,000	($48,000)	$305,000	$121,000	($122,000)	$256,000	$26,992	$3,846	$19,780	$23,060	$73,678	($82,705)	($87,387)	($88,447)	($86,762)	($345,302)
Special items, net of taxes	(105,000)	70,000	(268,000)	(83,000)	164,000	(117,000)	-	-	-	-	-	-	-	-	-	-
Net Income after special items	**$38,000**	**$22,000**	**$37,000**	**$38,000**	**$42,000**	**$139,000**	**$26,992**	**$3,846**	**$19,780**	**$23,060**	**$73,678**	**($82,705)**	**($87,387)**	**($88,447)**	**($86,762)**	**($345,302)**
Reported EPS - Diluted	$0.35	($0.11)	$0.72	$0.29	($0.29)	$0.61	$0.06	$0.01	$0.03	$0.04	$0.14	($0.14)	($0.15)	($0.15)	($0.15)	($0.60)
Recurring EPS - Diluted	**$0.09**	**$0.05**	**$0.09**	**$0.09**	**$0.10**	**$0.33**	**$0.06**	**$0.01**	**$0.03**	**$0.04**	**$0.14**	**($0.14)**	**($0.15)**	**($0.15)**	**($0.15)**	**($0.60)**
Basic shares outstanding	410,850	421,000	423,500	421,800	420,400	421,675	458,833	569,800	569,800	569,800	542,058	569,800	569,800	569,800	569,800	569,800
Diluted shares outstanding	410,850	421,000	423,500	421,800	422,000	422,075	460,579	571,969	571,969	571,969	544,121	571,969	571,969	571,969	571,969	571,969
Discretionary Cashflow (DCF):																
Net Income	$143,000	($48,000)	$305,000	$121,000	($122,000)	$256,000	$26,992	$3,846	$19,780	$23,060	$73,678	($82,705)	($87,387)	($88,447)	($86,762)	($345,302)
DD&A	$777,000	219,000	221,000	241,000	247,000	$928,000	280,086	357,181	376,145	386,032	$1,399,444	373,560	376,958	384,756	383,947	$1,519,221
Deferred taxes	$74,000	(14,000)	84,000	39,000	(20,000)	$89,000	8,062	1,149	5,908	6,888	$22,008	(24,704)	(26,103)	(26,419)	(25,916)	($103,142)
Impairment of O&G properties	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0
Stock-based compensation	$32,000	8,000	8,000	9,000	9,000	$34,000	9,000	10,000	10,000	10,000	$39,000	10,000	10,000	10,000	10,000	$40,000
Other	($1,000)	111,000	(313,000)	(107,000)	226,000	($83,000)	20,000	20,000	20,000	20,000	$80,000	20,000	20,000	20,000	20,000	$80,000
Discretionary cash flow (DCF)	$1,025,000	$276,000	$305,000	$303,000	$340,000	$1,224,000	$344,140	$392,176	$431,833	$445,980	$1,614,129	$296,151	$293,469	$299,890	$301,268	$1,190,778
Diluted DCFPS	**$2.49**	**$0.66**	**$0.72**	**$0.72**	**$0.81**	**$2.90**	**$0.75**	**$0.69**	**$0.75**	**$0.78**	**$2.97**	**$0.52**	**$0.51**	**$0.52**	**$0.53**	**$2.08**
Margin Analysis ($/boe):																
E&P Revenue	$38.24	$36.93	$37.74	$36.48	$37.20	$37.08	$36.12	$32.60	$33.11	$33.00	$33.55	$27.18	$26.90	$26.85	$27.07	$27.00
Production expense	9.25	8.95	9.43	8.90	8.98	9.06	8.62	7.50	7.56	7.45	7.73	7.52	7.50	7.51	7.51	7.51
DD&A	16.75	15.68	15.22	15.10	14.99	15.23	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00
G&A	3.23	2.79	2.75	2.63	3.10	2.82	2.17	1.97	1.83	1.87	1.94	1.71	1.70	1.66	1.79	1.72
Interest	3.51	2.93	2.75	2.38	2.43	2.61	2.18	2.16	2.05	2.00	2.09	2.07	2.05	2.01	2.01	2.03
Cash taxes	0.00	0.00	0.00	0.00	(1.15)	(0.31)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Discretionary cash flow	22.09	19.76	21.00	18.99	20.63	20.09	19.66	17.57	18.37	18.48	18.45	12.68	12.46	12.47	12.55	12.54
EBITDAX	$1,081,000	$312,000	$339,000	$352,000	$366,000	$1,369,000	$382,269	$440,430	$480,087	$494,233	$1,797,019	$344,404	$341,723	$348,144	$349,522	$1,383,793

Source: SFG Estimates

Exhibit 25: XEC Income Statement

Cimarex Energy (XEC)	2018	1Q '19	2Q '19	3Q '19	4Q '19	2019	1Q '20E	2Q '20E	3Q '20E	4Q '20E	2020E	1Q '21E	2Q '21E	3Q '21E	4Q '21E	2021E
Commodity Prices																
WTI Crude Oil ($/bbl)	$64.81	$54.72	$59.90	$56.41	$56.94	$56.99	$48.00	$30.00	$35.00	$35.00	$37.00	$40.00	$40.00	$40.00	$40.00	$40.00
Henry Hub Nat Gas ($/mmbtu)	$3.11	$3.17	$2.65	$2.25	$2.50	$2.64	$1.95	$2.00	$2.20	$2.50	$2.16	$2.60	$2.25	$2.50	$2.65	$2.50
Realized Oil ($/bbl)	$56.61	$48.87	$52.28	$50.78	$55.51	$51.98	$48.14	$35.87	$37.48	$37.62	$39.78	$40.29	$39.21	$38.64	$38.65	$39.19
Realized NGL ($/bbl)	$22.92	$16.44	$13.08	$10.80	$14.13	$13.55	$10.84	$7.88	$7.86	$9.09	$8.93	$9.20	$8.78	$8.27	$8.96	$8.80
Realized Nat Gas ($/mmbtu)	$1.99	$1.91	$0.85	$1.15	$1.28	$1.29	$0.70	$0.80	$1.05	$1.28	$0.96	$1.16	$0.80	$1.53	$1.56	$1.26
Daily Production																
Crude - bbl/d	67,699	79,415	83,450	89,750	92,050	86,211	89,950	88,350	91,450	88,550	89,577	87,150	88,450	87,050	88,050	87,676
NGL - bbl/d	60,258	72,956	80,350	77,700	78,550	77,405	74,800	72,200	73,600	70,650	72,809	70,850	70,950	69,600	69,700	70,270
Nat Gas - Mcf/d	563,950	639,100	665,800	718,000	732,600	689,211	686,300	656,700	666,300	637,300	661,596	604,700	600,500	588,400	585,100	594,604
Equivalent - Mcfe/d	1,331,692	1,553,326	1,648,600	1,722,700	1,756,200	1,670,906	1,674,800	1,620,000	1,656,600	1,592,500	1,635,913	1,552,700	1,556,900	1,528,300	1,531,600	1,542,279
STATEMENT OF OPERATIONS																
(data in thousands, except per share)																
Revenues:																
Oil & gas sales	$2,297,645	$567,221	$537,810	$570,577	$646,313	$2,321,921	$487,108	$324,080	$401,198	$409,190	$1,621,577	$424,871	$411,102	$444,998	$454,323	$1,735,293
Gas gathering (net) and other	(592)	(2,584)	(4,952)	(2,165)	4,652	(5,049)	-	-	-	-	-	-	-	-	-	-
Total revenues	$2,297,053	$564,637	$532,858	$568,412	$650,965	$2,316,872	$487,108	$324,080	$401,198	$409,190	$1,621,577	$424,871	$411,102	$444,998	$454,323	$1,735,293
Costs & expenses:																
DD&A	$597,615	$192,466	$215,484	$230,172	$252,637	$890,759	$228,610	$221,130	$228,611	$219,765	$898,116	$203,792	$206,614	$205,047	$205,490	$820,942
Production (LOE & workover)	293,213	77,233	87,726	88,300	82,722	335,981	83,824	78,624	80,014	76,918	319,379	72,201	73,200	72,645	72,802	290,848
Transportation and processing	200,802	53,608	48,331	52,697	64,780	219,416	60,963	58,968	60,963	58,604	239,498	55,897	56,671	56,241	56,363	225,173
Taxes other than on income	125,169	33,694	41,033	30,873	43,353	148,953	31,662	21,065	26,078	26,597	105,402	27,617	26,722	28,925	29,531	112,794
G&A	80,850	29,084	24,911	15,499	26,349	95,843	24,000	25,000	25,000	28,000	102,000	25,000	25,000	25,000	28,000	103,000
Stock-based compensation	22,895	6,713	6,494	6,797	6,394	26,398	7,000	7,000	7,000	7,000	28,000	7,000	7,000	7,000	7,000	28,000
Impairments	-	-	-	108,879	618,693	727,572	-	-	-	-	-	-	-	-	-	-
Other	15,500	8,326	590	10,141	248	19,305	-	-	-	-	-	-	-	-	-	-
Total operating expense	$1,336,044	$401,124	$424,569	$543,358	$1,095,176	$2,464,227	$436,059	$411,787	$427,665	$416,884	$1,692,395	$391,506	$395,207	$394,858	$399,186	$1,580,757
Operating Income	$961,009	$163,513	$108,289	$25,054	($444,211)	($147,355)	$51,050	($87,707)	($26,467)	($7,694)	($70,818)	$33,365	$15,895	$50,139	$55,137	$154,537
Other income (expense):																
Interest expense	($47,369)	($11,663)	($7,869)	($8,322)	($9,300)	($37,154)	($7,957)	($7,957)	($7,957)	($7,957)	($31,829)	($7,957)	($7,957)	($7,957)	($7,957)	($31,829)
Derivative gains (losses)	85,959	(115,452)	40,768	38,735	(40,901)	(76,850)	24,618	63,988	31,993	31,579	152,179	13,115	4,673	-	-	17,788
Other income (expense)	22,908	(2,009)	2,167	139	1,183	1,480	-	-	-	-	-	-	-	-	-	-
Total other income (expense)	61,498	(129,124)	35,066	30,552	(49,018)	(112,524)	16,661	56,031	24,036	23,622	120,350	5,158	(3,284)	(7,957)	(7,957)	(14,041)
Pre-tax income	**$1,022,507**	**$34,389**	**$143,355**	**$55,606**	**($493,229)**	**($259,879)**	**$67,711**	**($31,676)**	**($2,431)**	**$15,928**	**$49,532**	**$38,522**	**$12,611**	**$42,182**	**$47,180**	**$140,496**
Income tax expense (benefit)	$230,656	$8,073	$34,046	$15,079	($109,128)	($51,930)	$14,896	($6,969)	($535)	$3,504	$10,897	$8,475	$2,774	$9,280	$10,380	$30,909
Preferred Dividends			$0	$0	$0	$0	$1,270	$1,270	$1,270	$1,270	$5,078	$1,270	$1,270	$1,270	$1,270	$5,078
Reported Net Income	$791,851	$26,316	$109,309	$40,527	($384,101)	($207,949)	$51,545	($25,977)	($3,166)	$11,154	$33,557	$28,778	$8,567	$31,633	$35,531	$104,509
Special items, net of taxes	(86,979)	91,011	(26,291)	52,381	504,466	621,567	-	-	-	-	-	-	-	-	-	-
Net Income after special items	**$704,872**	**$117,327**	**$83,018**	**$92,908**	**$120,365**	**$413,618**	**$51,545**	**($25,977)**	**($3,166)**	**$11,154**	**$33,557**	**$28,778**	**$8,567**	**$31,633**	**$35,531**	**$104,509**
Reported EPS - Diluted	$8.29	$0.27	$1.10	$0.41	($3.77)	($2.09)	$0.51	($0.25)	($0.03)	$0.11	$0.33	$0.28	$0.08	$0.31	$0.35	$1.03
Recurring EPS - Diluted	**$7.38**	**$1.22**	**$0.82**	**$0.93**	**$1.18**	**$4.16**	**$0.52**	**($0.24)**	**($0.02)**	**$0.12**	**$0.38**	**$0.29**	**$0.10**	**$0.32**	**$0.36**	**$1.08**
Basic shares outstanding	94,661	95,922	99,658	99,735	101,903	99,305	101,903	101,903	101,903	101,903	101,903	101,903	101,903	101,903	101,903	101,903
Diluted shares outstanding	95,523	95,932	99,665	99,735	101,903	99,309	101,903	101,903	101,903	101,903	101,903	101,903	101,903	101,903	101,903	101,903
Discretionary Cashflow (DCF):																
Net Income	$791,851	$26,316	$109,309	$40,527	($384,101)	($207,949)	$51,545	($25,977)	($3,166)	$11,154	$33,557	$28,778	$8,567	$31,633	$35,531	$104,509
DD&A	597,615	192,466	215,484	230,172	252,637	890,759	228,610	221,130	228,611	219,765	898,116	203,792	206,614	205,047	205,490	820,942
Deferred taxes	233,663	8,073	34,046	15,079	(109,660)	(52,462)	14,896	(6,969)	(535)	3,504	10,897	8,475	2,774	9,280	10,380	30,909
Stock-based compensation	22,895	6,713	6,494	6,797	6,394	26,398	7,000	7,000	7,000	7,000	28,000	7,000	7,000	7,000	7,000	28,000
Unrealized derivative loss (gain)	67,535	106,401	(34,531)	(35,921)	40,901	76,850	0	0	0	0	0	0	0	0	0	0
Other	(179,980)	11,093	5,560	104,075	609,816	730,544	0	0	0	0	0	0	0	0	0	0
Discretionary cash flow (DCF)	$1,533,579	$351,062	$336,362	$360,729	$415,987	$1,464,140	$302,052	$195,185	$231,910	$241,423	$970,570	$248,045	$224,955	$252,960	$258,400	$984,360
Diluted DCFPS	**$16.05**	**$3.66**	**$3.37**	**$3.62**	**$4.08**	**$14.74**	**$2.96**	**$1.92**	**$2.28**	**$2.37**	**$9.52**	**$2.43**	**$2.21**	**$2.48**	**$2.54**	**$9.66**
Margin Analysis ($/mcfe):																
E&P Revenue	$28.36	$24.34	$21.51	$21.60	$24.00	$22.84	$19.18	$13.19	$15.79	$16.76	$16.25	$18.24	$17.41	$18.99	$19.35	$18.50
Production costs	5.16	4.76	5.15	4.51	4.68	4.77	4.55	4.06	4.18	4.24	4.26	4.29	4.23	4.33	4.36	4.30
DD&A	7.38	8.26	8.62	8.71	9.38	8.76	9.00	9.00	9.00	9.00	9.00	8.75	8.75	8.75	8.75	8.75
G&A (ex non-cash comp.)	1.00	1.25	1.00	0.59	0.98	0.94	0.94	1.02	0.98	1.15	1.02	1.07	1.06	1.07	1.19	1.10
Interest	0.58	0.50	0.31	0.32	0.35	0.37	0.31	0.32	0.31	0.33	0.32	0.34	0.34	0.34	0.34	0.34
Cash taxes	(0.04)	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Discretionary cash flow	18.93	15.07	13.45	13.66	15.45	14.40	11.89	7.94	9.13	9.89	9.73	10.65	9.53	10.79	11.00	10.49
EBITDAX	$1,735,013	$353,641	$336,504	$373,716	$433,513	$1,497,374	$311,278	$204,411	$241,137	$250,650	$1,007,476	$257,271	$234,182	$262,186	$267,627	$1,021,266

Source: SFG Estimates

Catalysts

Apache Corp. - APA:
Commodity price volatility, Suriname exploration success, improving well productivity in Permian Basin

Centennial Resource Development - CDEV:
Improving capital efficiency and additional delineation in Northern Delaware Basin.

Continental Resources, Inc. - CLR:
Improving overall oil cut; improved well results in SCOOP and STACK with down-spacing tests.

Cabot Oil & Gas Corporation - COG:
Recovery in natural gas prices; step-up in capital return to shareholders (dividend increase/share buyback); continued Upper Marcellus delineation.

ConocoPhillips - COP:
Commodity price volatility, exploration/appraisal results at Willow/Harpoon in Alaska, bolt-on acquisition in "Big Three" Resource plays

Concho Resources Inc. - CXO:
Improvement in capital efficiency from wider-spaced development; FCF inflection.

Devon Energy - DVN:
Execution of remaining divestitures and expanded share repurchase program.

EOG Resources, Inc. - EOG:
Continued strong operational execution and higher capital return to shareholders with incremental free cash flow.

Diamondback Energy, Inc. - FANG:
Resumption of sequential oil growth; continued reduction in well costs.

Hess Corporation - HES:
Commodity price volatility, execution on Liza Phase 2 and Payara development projects; incremental Guyana discoveries, improving well productivity in Bakken

Magnolia Oil & Gas Corp. - MGY:
Giddings Field delineation results; production/FCF growth.

Marathon Oil Corp. - MRO:
Texas Woodford exploration results, Permian appraisal results; accelerated share repurchases with free cash flow.

Noble Energy, Inc. - NBL:
Commodity price volatility, Delaware Basin M&A, exploration results in Colombia and PRB

Oasis Petroleum, Inc. - OAS:
Additional monetization of assets (non-core Bakken and/or portion of mid-stream); Delaware Basin delineation (ongoing).

Occidental Petroleum Corporation - OXY:
Quick execution of asset sales/debt paydown; improving Permian well productivity/capital efficiency.

Parsley Energy, Inc. - PE:
Integration of newly acquired JAG assets; improving capital efficiency from revised development plans.

Pioneer Natural Resources Co. - PXD:
Execution on capex front and improving well productivity.

Range Resources Corporation - RRC:
Recovery in natural gas/NGL prices and continued leverage reduction; additional asset sales to accelerate balance sheet improvement.

SM Energy Co. - SM:
Inflection to free cash flow; continued improvement in operating costs; Eagle Ford completion tests and potential sale.

Southwestern Energy Co. - SWN:
Progress toward cash flow neutrality; improvement in natural gas prices.

WPX Energy - WPX:
Transition to free cash flow; additional delineation enhanced completion results.

Cimarex Energy Co. - XEC:
Increased visibility of free cash flow profile.

Downside or Upside risk

Apache Corp. - APA:
Our downside target is $2, which is based on ~8.0x our 2021E DACF estimate at a $35 WTI/$2.25 HH deck.

Centennial Resource Development - CDEV:
Downside risk to our price target is $0.25, which is based on 5.0x our 2021E DACF estimate at $35 WTI/$2.25 HH price deck.

Continental Resources, Inc. - CLR:
Downside risk assessment is $5, based on ~5.0x 2021E DACF estimate, based on a $35 WTI/$2.25 HH price deck.

Cabot Oil & Gas Corporation - COG:
Downside risk assessment is $14, based on ~6.5x 2021E DACF estimate, using a $35 WTI/$2.25 HH price deck.

ConocoPhillips - COP:
Our downside target is $27, which is based on ~6.0x our 2021E DACF estimate at a $35 WTI/$2.25 HH deck.

Concho Resources Inc. - CXO:
Downside risk assessment is $41, based on 5.5x our 2021E DACF estimate, based on a $35 WTI/$2.25 HH price deck.

Devon Energy - DVN:
Downside risk assessment is $6, which is based on ~4.0x our 2021E DACF estimate, based on a $35 WTI/$2.25 HH price deck.

EOG Resources, Inc. - EOG:
Downside risk assessment is $29, or ~5.0x our 2021E DACF estimate, based on a $35 WTI/$2.25 HH price deck.

Diamondback Energy, Inc. - FANG:
Downside risk assessment is $21, ~5.0x our 2021E DACF estimate, based on a $35 WTI/$2.25 HH price deck.

Hess Corporation - HES:
Our downside target is $25, which is based on ~8.0x our 2021E DACF estimate at a $35 WTI/$2.25 HH deck.

Magnolia Oil & Gas Corp. - MGY:
Downside risk assessment is $3, or ~4.0x our 2021E DACF estimate, based on a $35 WTI/$2.25 HH price deck.

Marathon Oil Corp. - MRO:
Downside risk is $3, or ~5.0x our 2021E E&P DACF estimate, based on a $35 WTI/$2.25 HH price deck.

Noble Energy, Inc. - NBL:
Our downside target is $3, which is based on ~6.5x our 2021E DACF estimate at a $35 WTI/$2.25 HH deck.

Oasis Petroleum, Inc. - OAS:
Downside risk is $0.25, or ~9.0x our 2021E DACF estimate, based on a $35 WTI/$2.25 HH price deck.

Occidental Petroleum Corporation - OXY:
Downside risk to our price target is $3, which is based on ~7.3x our 2021E DACF estimate at a $35 WTI/$2.25 HH price deck.

Parsley Energy, Inc. - PE:
Downside risk assessment is $4, based on ~3.5x our 2021E DACF estimate, based on a $35 WTI/$2.25 HH price deck.

Pioneer Natural Resources Co. - PXD:
Downside risk assessment is $55, or ~5.5x our 2021E DACF estimate, based on a $35 WTI/$2.25 HH price deck.

Range Resources Corporation - RRC:
Upside risk is $4, or ~7.5x our 2021E DACF based on a $45 WTI/$2.60 HH price deck.

SM Energy Co. - SM:
Downside risk assessment is $1, or ~5.5x our 2021E DACF estimate assuming a $35 WTI/$2.25 HH price deck.

Southwestern Energy Co. - SWN:
Upside risk assessment is $2, or ~5.0x our 2021E DACF estimate, based on $2.60 HH (and $45 WTI) price deck.

WPX Energy - WPX:
Downside risk assessment is $3, based on ~4.5x our 2021E DACF at a price deck of $35 WTI/$2.25 HH.

Cimarex Energy Co. - XEC:
Downside risk assessment is $9, or ~4.0x our 2021E DACF estimate, based on a $35 WTI/$2.25 HH price deck.

Price target valuation and risks

Apache Corp. (APA, Price: $8.07, Price Target: $9.00):
Our price target for APA is $9, which is based on ~8.0x 2021E debt-adjusted cash flow (DACF) at our $40 WTI/$2.50 HH price deck.

Upside risks: Oil price recovery, Suriname exploration results.

Downside risks: Commodity price volatility, Suriname exploration results, significant exposure to natural gas/NGL price.

Centennial Resource Development (CDEV, Price: $0.56, Price Target: $0.60):
Our price target is now $0.60, which is based on ~5.0x 2021E debt-adjusted cash flow (DACF) at our $40 WTI/$2.50 HH price deck.

Key risks to the E&P sector and CDEV include commodity price volatility and geologic & well performance variability.

Continental Resources, Inc. (CLR, Price: $9.82, Price Target: $10.00):
Our $10 price target is based on ~5.0x 2021E DACF at our $40 WTI/$2.50 HH price deck.

Key risks to the E&P sector and CLR include commodity price volatility and geologic & well performance variability.

Cabot Oil & Gas Corporation (COG, Price: $18.37, Price Target: $22.00):
Our $22 price target is based on ~8.0x 2021E DACF at our $40 WTI/$2.50 HH price deck.

Key risks to the E&P sector and COG include commodity price volatility and geologic & well performance variability.

ConocoPhillips (COP, Price: $31.38, Price Target: $42.00):
Our price target for COP is $42, which is based on ~7.0x 2020E debt-adjusted cash flow (DACF) at $40 WTI/$2.50 HH.

Downside risks: Commodity price volatility, elevated political risks surrounding Alaska, execution risk around "Big Three" Resource play production ramp.

Concho Resources Inc. (CXO, Price: $46.87, Price Target: $64.00):

Our $64 price target is based on ~6.5x our 2021E DACF at $40 WTI/$2.50 HH.

Key risks to the E&P sector and CXO include commodity price volatility and geologic & well performance variability.

Devon Energy (DVN, Price: $8.70, Price Target: $13.00):
Our $13 price target is based on ~5.0x 2021E DACF at our $40 WTI/$2.50 HH price deck.

Key risks to the E&P sector and DVN include commodity price volatility and geologic and well performance variability.

EOG Resources, Inc. (EOG, Price: $34.80, Price Target: $55.00):
Our $55 price target is based on ~7.0x our 2021E DACF at our $40 WTI/$2.50 HH price deck.

Key risks to the E&P sector and EOG include commodity price volatility and geologic & well performance variability.

Diamondback Energy, Inc. (FANG, Price: $27.19, Price Target: $40.00):
Our $40 price target is based on ~5.5x 2020E DACF at our $40 WTI/$2.50 HH price deck.

The key risks to the E&P sector and FANG include commodity price volatility and geologic and well performance variability.

Hess Corporation (HES, Price: $34.92, Price Target: $46.00):
Our price target for HES is $46, which is based ~10.0x 2020E debt-adjusted cash flow (DACF) at our $40 WTI/$2.50 HH price deck.

Downside risks: Commodity price volatility, Guyana execution risk, overruns on capital budget for upcoming Guyana development project, Bakken inventory depth in weaker commodity price environment.

Magnolia Oil & Gas Corp. (MGY, Price: $4.98, Price Target: $6.00):
Our $6 price target is based on ~5.5x 2021E DACF at our $40 WTI/$2.50 HH price deck.

The key risks to the E&P sector and MGY include commodity price volatility and geologic and well performance variability.

Marathon Oil Corp. (MRO, Price: $4.53, Price Target: $5.50):
Our $5.50 price target is based on ~5.0x 2021E DACF at our $40 WTI/$2.50 HH price deck.

Key risks to the E&P sector and MRO include commodity price volatility and geologic and well performance variability.

Noble Energy, Inc. (NBL, Price: $7.19, Price Target: $8.00):
Our $8 price target is based on ~6.5x 2021E debt-adjusted cash flow (DACF) at our $40 WTI/$2.50 HH price deck.

Upside risks: Oil price recovery.

Downside risks: Commodity price volatility, Permian well results/M&A, political uncertainty around Colorado elections/policy.

Oasis Petroleum, Inc. (OAS, Price: $1.00, Price Target: $1.00):
Our $1.00 price target is based on ~7.5x 2021E DACF at our $40 WTI/$2.50 HH price deck.

Key risks to the E&P sector and OAS include commodity price volatility and geologic and well performance variability.

Occidental Petroleum Corporation (OXY, Price: $14.26, Price Target: $15.00):
Our $15 price target is based on ~7.3x 2021E debt-adjusted cash flow (DACF) at our $40 WTI/$2.50 HH price deck.

Key risks: With a higher debt load, OXY's performance is more susceptible to commodity price volatility. Additionally, delays in completing already announced asset sale or executing additional divestitures, could delay company's de-leveraging targets. Also, we are assuming overall improvement in its Permian capital efficiency after incorporating

Anadarko assets. Inability to realize these gains or to achieve planned well cost reduction could adversely impact the company's ability to reduce its debt load.

Parsley Energy, Inc. (PE, Price: $6.55, Price Target: $11.00):
Our $11 price target is based on ~5.0x our 2021E DACF at our $40 WTI/$2.50 HH price deck.

Key risks to the E&P sector and PE include commodity price volatility and geologic and well performance variability.

Pioneer Natural Resources Co. (PXD, Price: $70.68, Price Target: $100.00):
Our $100 price target is based on ~7.5x 2021E DACF at our $40 WTI/$2.50 HH price deck.

Key risks to the E&P sector and PXD include commodity price volatility and geologic & well performance variability.

Range Resources Corporation (RRC, Price: $2.82, Price Target: $2.50):
Our $2.50 price target is based on ~7.5x 2020E DACF at our $40 WTI/$2.50 HH price deck.

Key risks to the E&P sector and RRC include commodity price volatility and geologic and well performance variability.

SM Energy Co. (SM, Price: $2.33, Price Target: $2.50):
Our $2.50 price target is based on ~4.8x 2021E DACF at our $40 WTI/$2.50 HH price deck.

Key risks to the E&P sector and SM include commodity price volatility and geologic and well performance variability.

Southwestern Energy Co. (SWN, Price: $1.77, Price Target: $1.50):
Our $1.50 price target is based on ~5.0x 2021E DACF at our $40 WTI/$2.50 HH price deck.

Key risks to the E&P sector and SWN include commodity price volatility and geologic and well performance variability.

WPX Energy (WPX, Price: $4.50, Price Target: $7.00):
Our $7 price target is based on ~5.0x our 2021E DACF at our $40 WTI/$2.50 HH price deck.

Key risks to the E&P sector and WPX include commodity price volatility and geologic & well performance variability.

Cimarex Energy Co. (XEC, Price: $18.10, Price Target: $19.00):
Our $19 price target is based on ~4.0x 2021E DACF at our $40 WTI/$2.50 HH price deck.

Key risks to the E&P sector and XEC include commodity price volatility and geologic and well performance variability.

Analyst Certification

I, Biju Perincheril, hereby certify that the views each of us has expressed in this research report accurately reflect each of our respective personal views about the subject securities and issuers. We also certify that no part of our respective compensation was, is, or will be, directly or indirectly, related to the specific recommendations or view expressed in this research report.

Important Disclosures

This is a compendium report covering six or more companies. Disclosures for any of the covered securities mentioned in this note can be obtained by contacting Research Compliance toll-free at 888-744-6684 or by visiting our disclosure website at https://sig.bluematrix.com/sellside/Disclosures.action

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The following data elements on this report were sourced from Bloomberg LP: Price (yesterday's close), 52-week high, 52-week low, Shares outstanding, Average daily trading volume, Volume (contracts). Any others will be specifically sourced.

SFG employs the following rating system:

Positive: We expect this stock to appreciate by at least 15% over the next 12 months.

Neutral: We expect this stock to perform within a range of +/-15 percentage points over the next 12 months.

Negative: We expect this stock to depreciate by at least 15% over the next 12 months. .

Suspended: The previously published rating and/or estimates are currently suspended and under review.

Prior to July 2015 our rating system also required a 20% +/- expected return over 12 months to initiate with a Positive/Negative rating.

Defined Credit Terms

Gross debt + preferred TEV: (Gross Debt + Preferred) / Total Enterprise Value (expressed as a %).

Net debt/EBITDA: Net Debt (gross debt less cash on hand) / EBITDA = forward year EBITDA estimate.

Free cash flow: Forward EBITDA estimate less cash taxes less cash interest less total capex.

FCF yield: FCF Yield ((FCF/ Fully Diluted shares outstanding/current share price) (expressed as a %)).

YTM: Yield-to-maturity ("YTM") implied by any of its bonds outstanding that are due in 5 years ((or closest to)(expressed as a %)).

5-yr treasury yield: 5-year US Treasury yield (expressed as a %).

Volatility Definitions

Volume: The 20-day average option contract volume for the symbol.

Skew Rank: The current day's Skew values compared to the past year's worth of skew values and then rank the current day's value. Past year in the calculation is 252 previous trading days which includes the last trading day.

Implied Volatility: Implied Volatility is the at-the-forward volatility level implied by market option prices for 90 days. While implied volatility is specific to the time frame selected, it is always presented as an annualized standard deviation.

Realized Volatility: It is the Realized Volatility of a financial instrument over 90 days. Generally, this measure is calculated by determining the average deviation from the average price of a financial instrument in the given time period. This measure is frequently compared with implied volatility to determine if options prices are over- or undervalued. It is also known as historical volatility.

Ratings Distribution & Investment Banking Disclosure

Covered companies in each Category	Investment banking client in each category
Positive (Buy) 57.45% (135)	Positive (Buy) 0.00% (0)
Neutral (Hold) 40.00% (94)	Neutral (Hold) 0.00% (0)
Negative (Sell) 2.55% (6)	Negative (Sell) 0.00% (0)

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Exhibit 39

DOW JONES

DOW JONES NEWSWIRES

HD **Traders Bet on Falling 'Fear Gauge'**

BY By Gunjan Banerji

WC 346 words

PD 17 March 2020

ET 13:33

SN Dow Jones Institutional News

SC DJDN

LA English

LP

The Cboe Volatility Index, or VIX, closed at its highest level in history Monday when U.S. shares recorded the steepest decline since the Black Monday stock-market crash of 1987. Some investors are already betting on its rapid fall.

The volatility gauge tends to rise when markets fall and investors reach for stock protection through the options market.

TD

The VIX climbed to 82.69 Monday, topping its high of about 80 in 2008. After the financial crisis, trading derivatives tied to the VIX took off as people sought to profit from its swings.

Many are wagering its recent jump won't be long-lived. Betting on its fall through what is known as the short volatility trade has been particularly popular in recent years. This can be a risky tactic that backfires when stocks slide as sharply as they have in recent weeks as the spread of coronavirus has raised the risk of a recession.

As stock markets staged a modest rebound Tuesday, some of the most popular contracts were tied to VIX falling to 27 or 14, Trade Alert data show, closer to levels hit earlier this year when major indexes hit records.

Still, turbulence in markets has been high, triggering diverging views on the gauge's path. Analysts at Credit Suisse Group AG said another steep selloff similar to Monday's could push the VIX above 100. The S&P 500 fell 12% that day, one of the worst sessions in its history.

Some options traders have already been positioning for that, scooping up contracts tied to the VIX jumping as high as 100 or even 130, Trade Alert data show. Those are among the smaller positions outstanding but were some of Monday's most popular trades, according to Trade Alert.

"While this is surely possible, we believe it is highly improbable," wrote Jonathan Golub, an analyst at Credit Suisse.

The gauge fell 11% to 73.65 in midday trading Tuesday.

(END) Dow Jones Newswires

March 17, 2020 13:33 ET (17:33 GMT)

NS m11 : Equity Markets | m15 : Derivative Securities | mcat : Commodity/Financial Market News | mequid : Equity Derivatives | neqac : Equities Asset Class News | ntab : Tables | ntop : Top Wire News | nttwn : Today's Top Wire News | nrmf : Routine Market/Financial News | ncat : Content Types | ndj : Dow Jones Top Stories | nfact : Factiva Filters | nfce : C&E Exclusion Filter | niwe : IWE Filter | redit : Selection of Top Stories/Trends/Analysis

RE usa : United States | namz : North America

PUB Dow Jones & Company, Inc.

AN Document DJDN000020200317eg3h003j7

Exhibit 40

USA TODAY

SE MONEY

HD **How does this bear market compare?**

BY Jim Sergent; Veronica Bravo

WC 756 words

PD 18 March 2020

SN USA Today

SC USAT

PG B.1

VOL ISSN:07347456

LA English

LP

We're in a bear market. Now what?

All three major U.S. stock indexes have moved into bear territory this month after multiple tumultuous days on Wall Street. While this may seem a bit foreign after an 11-year bull market, bears are part of investing.

TD

A bear market, you may remember, is defined as a drop of 20% or more from a prior closing high. The S&P 500, Dow Jones Industrial Average and Nasdaq have all closed 20% below the all-time highs they reached in February to end their bull-market runs.

The uncertainty surrounding the new coronavirus, or COVID-19, has left investors wondering what will unfold during the coming days and weeks, including the likelihood of a U.S. or global recession as countries shut down business and travel to contain the spreading virus.

How much longer the decline will continue is impossible to say, but the charts we've compiled from the last 13 bear markets can offer perspective of how markets have tumbled and later recovered.

This is the fastest bear

Only the Great Depression and the 1987 Black Monday crash come close to matching the speed with which this downturn has turned into a bear market. This bear market was 10 times faster than the average of 164 days.

Markets could

be choppy for weeks

History doesn't suggest there will be a bottom in the near future. While we may not experience massive declines such as those we've endured in recent weeks, it's important to note that the shortest bear market lasted three months.

Bears cut more deeply

These are still the early days of this bear market, and while the rapid descent of stocks might make this feel like a historically sharp fall, so far, the market decline is smaller than the average bear. The S&P 500 has fallen by about 40% on average.

It's a long way back up

Once the bear market is over, getting back to the top often has been a long climb. No climb matches that of the Great Depression stock market. It took about 25 years (Sept. 22, 1954) for the S&P index to reach 31.92 after it closed there on Sept. 7, 1929.

The return to a peak has been significantly shorter in other bear markets, but it's taken 3.3 years on average for investors to get back to where they started.

Just hang on

If you sold your S&P 500 mutual funds or ETFs before Feb. 19, you're one of the lucky ones. Rarely are any of us so lucky.

Avoiding sell-offs is difficult, if not impossible. Investors often sell when U.S. markets suffer staggering losses as they have in the past few weeks, and they may be left behind when stocks make their biggest advances.

Consider how much you would have gained if you had sold before 10 of the worst days during the past 10 years.

If you invested $10,000 in the S&P 500 on March 9, 2010, you would have made $40,042 over the past decade or an 18.8% annual gain, according to Ned Davis Research.

Most of us aren't prescient enough to know what tomorrow will bring – especially right now. So you could try to buy and sell at just the right times, but just doing nothing might have a similar result.

When is it safe to go back in?

"Don't try to catch a falling knife" is a warning repeated frequently in times like this. When markets have fallen so significantly, it's tempting to think the market is on sale one day only to see it decline the next.

If you did sell recently, how do you know when things are getting back to normal?

One measure would be the volatility index created by the Chicago Board Options Exchange – ticker symbol: VIX. Some have called it the "fear gauge" because it indicates when investors are buying protection against declines in the market.

When the VIX begins closing higher than 20, it often indicates that investors are seeing troubling signs in the market.

Similarly, when the VIX starts to fall back to normal levels, investors foresee more regular market conditions in the near future.

In recent days the VIX has climbed to levels not even seen during the financial crisis in October 2008, signaling the continued uncertainty brought on by the coronavirus pandemic.

NS m11 : Equity Markets | gsars : Novel Coronaviruses | gmed : Medical Conditions | gcat : Political/General News | gcold : Respiratory Tract Diseases | ghea : Health | gspox : Infectious Diseases | mcat : Commodity/Financial Market News | ncat : Content Types | nfact : Factiva Filters | nfce : C&E Exclusion Filter

RE usa : United States | namz : North America

IPD Newspapers

PUB USA Today Information Network

AN Document USAT000020200318eg3i0000u

Exhibit 41

UNITED STATES
SECURITIES AND EXCHANGE COMMISSION
Washington, D.C. 20549

FORM 8-K

CURRENT REPORT
Pursuant to Section 13 or 15(d)
of The Securities Exchange Act of 1934

Date of Report (Date of earliest event reported): July 29, 2020

APACHE CORPORATION

(Exact name of registrant as specified in its charter)

Delaware	1-4300	41-0747868
(State or other jurisdiction of incorporation)	(Commission File Number)	(IRS Employer Identification No.)

2000 Post Oak Boulevard
Suite 100
Houston, Texas 77056-4400
(Address of principal executive offices) (Zip Code)

Registrant's telephone number, including area code: (713) 296-6000

Check the appropriate box below if the Form 8-K filing is intended to simultaneously satisfy the filing obligation of the registrant under any of the following provisions:

☐ Written communications pursuant to Rule 425 under the Securities Act (17 CFR 230.425)
☐ Soliciting material pursuant to Rule 14a-12 under the Exchange Act (17 CFR 240.14a-12)
☐ Pre-commencement communications pursuant to Rule 14d-2(b) under the Exchange Act (17 CFR 240.14d-2(b))
☐ Pre-commencement communications pursuant to Rule 13e-4(c) under the Exchange Act (17 CFR 240.13e-4(c))

Securities registered pursuant to Section 12(b) of the Act:

Title of each class	Trading Symbol(s)	Name of each exchange on which registered
Common Stock, $0.625 par value	**APA**	**Nasdaq Global Select Market**

Indicate by check mark whether the registrant is an emerging growth company as defined in Rule 405 of the Securities Act of 1933 (§230.405 of this chapter) or Rule 12b-2 of the Securities Exchange Act of 1934 (§240.12b-2 of this chapter).

Emerging growth company ☐

If an emerging growth company, indicate by check mark if the registrant has elected not to use the extended transition period for complying with any new or revised financial accounting standards provided pursuant to Section 13(a) of the Exchange Act. ☐

The information in this Current Report on Form 8-K, including Exhibit 99.1 furnished herewith, is being furnished and shall not be deemed "filed" for purposes of Section 18 of the Exchange Act or otherwise subject to the liabilities of Section 18, and shall not be incorporated by reference in any filing under the Securities Act or the Exchange Act, except as set forth by specific reference in such filing.

Item 2.02. Results of Operations and Financial Condition.

On July 29, 2020, Apache Corporation issued a press release announcing financial and operating results for the fiscal quarter ended June 30, 2020. The full text of the press release is furnished herewith as Exhibit 99.1 and incorporated herein by reference.

Item 9.01. Financial Statements and Exhibits.

(d) Exhibits.

Exhibit No.	Description
99.1	Press Release of Apache Corporation dated July 29, 2020.
104	Cover Page Interactive Data File (embedded within the Inline XBRL document).

SIGNATURES

Pursuant to the requirements of the Securities Exchange Act of 1934, the registrant has duly caused this report to be signed on its behalf by the undersigned hereunto duly authorized.

APACHE CORPORATION

Date: July 30, 2020

By: /s/ Rebecca A. Hoyt
Rebecca A. Hoyt
Senior Vice President,
Chief Accounting Officer, and Controller
(Principal Accounting Officer)

Exhibit 99.1

NEWS RELEASE

Apache Corporation Announces Second-Quarter 2020
Financial and Operational Results

Key Takeaways

- *Announced major discovery at Kwaskwasi today, third consecutive discovery in Block 58 offshore Suriname;*
- *Submitted appraisal plan for first discovery, Maka, in May; announced second discovery, Sapakara, in April;*
- *Posted second-quarter reported production of 435,000 barrels of oil equivalent (BOE) per day; adjusted production, which excludes Egypt noncontrolling interest and tax barrels, was 394,000 BOE per day;*
- *Delivered upstream capital investment below guidance; tracking toward the low end of full-year 2020 guidance range of $1.0 to $1.2 billion;*
- *Focused capital investments on higher-return international opportunities;*
- *Achieved annualized cost savings target of more than $300 million, approximately $225 million of which will be realized in 2020; and*
- *Implemented operational protocols and work-from-home-processes, successfully mitigating the impact of COVID-19 on Apache's operations, employees and communities.*

HOUSTON, July 29, 2020 – Apache Corporation (Nasdaq: APA) today announced its financial and operational results for the second-quarter 2020.

Apache reported a loss of $386 million or $1.02 per diluted common share during the second-quarter 2020. When adjusted for certain items that impact the comparability of results, Apache reported a second-quarter loss of $281 million, or $0.74 per share. Net cash provided by operating activities in the second quarter was $84 million, and adjusted EBITDAX was $235 million.

"Our exploration program offshore Suriname continues to deliver exciting results. Earlier today, we announced a major discovery at Kwaskwasi-1, our best well yet and third consecutive success in Block 58," said John J. Christmann IV, Apache's chief executive officer and president.

Following completion of operations at Kwaskwasi-1, a fourth exploration prospect, Keskesi East-1, will be drilled approximately 10 kilometers (6 miles) southeast of the Sapakara discovery well.

"Our continued success in Suriname, along with the steps we've taken to streamline our organization and further strengthen our financial position, prepare us well for the long term. Apache has achieved more than $300 million of combined, annualized LOE and overhead savings – doubling our original target – and delivered on our activity and capital reduction goal. These actions have lowered our free cash flow breakeven oil price to around $30 per barrel for the second half of 2020," he continued.

2020 capital budget and outlook

Apache delivered second-quarter upstream capital investment of $216 million and is tracking toward the lower end of its annual capital guidance range of $1.0 to $1.2 billion dollars. The company guided to third-quarter capital investment of approximately $190 million.

Second-quarter operational summary

Second-quarter reported production was 435,000 BOE per day, and adjusted production, which excludes Egypt noncontrolling interest and tax barrels, was 394,000 BOE per day.

Following a thorough operational and economic evaluation of all producing wells, Apache chose to curtail approximately 28,000 BOE per day during the second quarter to minimize the negative cash flow impacts of lower oil and NGL prices. The company shut-in an additional 7,000 BOE per day due to unscheduled pipeline downtime at Alpine High. As prices rebounded over the past several months, the company has now returned its curtailed volumes in the North Sea and Alpine High to production, along with a portion of curtailed oil volumes elsewhere in the Permian Basin.

Closing Remarks

“Our objectives remain unchanged despite the extreme market volatility in 2020. We will budget conservatively and return free cash flow to investors, initially in the form of debt reduction; maintain a balanced and diversified portfolio; and prioritize investment for long-term returns over production growth. We will also continue to advance our exploration program and follow-on appraisal activity in Block 58 offshore Suriname and maintain our capacity to generate material free cash flow in Egypt and the North Sea,” concluded Christmann.

Conference call

Apache will host a conference call to discuss its second-quarter 2020 results at 10 a.m. Central time, Thursday, July 30. The conference call will be webcast from Apache's website at www.apachecorp.com and investor.apachecorp.com, and the webcast replay will be archived there as well. The conference call will also be available for playback by telephone for one week beginning at approximately 4 p.m. Central time July 30. The number for the replay is 855-859-2056 or 404-537-3406 for international calls. The conference access code is 6166527. Sign up for email alerts to be reminded of the webcast at investor.apachecorp.com/alerts/email-alerts-subscription.

About Apache

Apache Corporation is an oil and gas exploration and production company with operations in the United States, Egypt and the United Kingdom and exploration activities offshore Suriname. Apache posts announcements, operational updates, investor information and all press releases on its website, www.apachecorp.com.

Additional information

Additional information follows, including reconciliations of adjusted earnings, adjusted EBITDAX, and upstream capital investment (non-GAAP financial measures) to GAAP measures and information regarding adjusted production. Apache's quarterly supplement is available at www.apachecorp.com/financialdata.

Non-GAAP financial measures

Apache's financial information includes information prepared in conformity with generally accepted accounting principles (GAAP) as well as non-GAAP financial information. It is management's intent to provide non-GAAP financial information to enhance understanding of our consolidated financial information as prepared in accordance with GAAP. Adjusted earnings, adjusted EBITDAX, and upstream capital investment are non-GAAP measures. This non-GAAP information should be considered by the reader in addition to, but not instead of, the financial statements prepared in accordance with GAAP. Each non-GAAP financial measure is presented along with the corresponding GAAP measure so as not to imply that more emphasis should be placed on the non-GAAP measure.

Forward-looking statements

This news release contains forward-looking statements within the meaning of Section 27A of the Securities Act of 1933 and Section 21E of the Securities Exchange Act of 1934. Forward-looking statements can be identified by words such as "anticipates," "intends," "plans," "seeks," "believes," "continues," "could," "estimates," "expects," "guidance," "may," "might," "outlook," "possibly," "potential," "projects," "prospects," "should," "will," "would," and similar references to future periods, but the absence of these words does not mean that a statement is not forward-looking. These statements include, but are not limited to, statements about future plans, expectations and objectives for Apache's operations, including statements about our capital plans, drilling plans, production expectations, asset sales, and monetizations. While forward-looking statements are based on assumptions and analyses made by us that we believe to be reasonable under the circumstances, whether actual results and developments will meet our expectations and predictions depend on a number of risks and uncertainties which could cause our actual results, performance, and financial condition to differ materially from our expectations. See "Risk Factors" in our 2019 Form 10-K, and in our quarterly reports on Form 10-Q, filed with the Securities and Exchange Commission ("SEC") for a discussion of risk factors that affect our business. Any forward-looking statement made by Apache in this news release speaks only as of the date on which it is made. Factors or events that could cause our actual results to differ may emerge from time to time, and it is not possible for us to predict all of them. Apache undertakes no obligation to publicly update any forward-looking statement, whether as a result of new information, future development or otherwise, except as may be required by law.

Cautionary note to investors

The United States Securities and Exchange Commission permits oil and gas companies, in their filings with the SEC, to disclose only proved, probable, and possible reserves that meet the SEC's definitions for such terms. Apache may use certain terms in this news release, such as "resources," "potential resources," "resource potential," "estimated net reserves," "recoverable reserves," and other similar terms that the SEC guidelines strictly prohibit Apache from including in filings with the SEC. Such terms do not take into account the certainty of resource recovery, which is contingent on exploration success, technical improvements in drilling access, commerciality and other factors, and are therefore not indicative of expected future resource recovery

and should not be relied upon. Investors are urged to consider carefully the disclosure in Apache's Annual Report on Form 10-K for the fiscal year ended Dec. 31, 2019 available from Apache at www.apachecorp.com or by writing Apache at: 2000 Post Oak Blvd., Suite 100, Houston, TX 77056 (Attn: Corporate Secretary). You can also obtain this report from the SEC by calling 1-800-SEC-0330 or from the SEC's website at www.sec.gov.

Contacts

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APA-F

APACHE CORPORATION
STATEMENT OF CONSOLIDATED OPERATIONS
(Unaudited)
(In millions, except per share data)

	For the Quarter Ended June 30,		For the Six Months Ended June 30,	
	2020	2019	2020	2019
REVENUES AND OTHER:				
Oil, natural gas, and natural gas liquids production revenues				
Oil revenues	$ 513	$ 1,397	$ 1,545	$ 2,707
Natural gas revenues	130	118	253	354
Natural gas liquids revenues	54	83	135	191
	697	1,598	1,933	3,252
Purchased oil and gas sales	55	18	163	42
Total revenues	752	1,616	2,096	3,294
Derivative instrument losses, net	(175)	(8)	(278)	(38)
Gain on divestitures, net	—	17	25	20
Other, net	19	(7)	32	(1)
	596	1,618	1,875	3,275
OPERATING EXPENSES:				
Lease operating expenses	264	389	599	754
Gathering, processing and transmission	72	76	143	164
Purchased oil and gas costs	46	15	132	37
Taxes other than income	23	46	56	97
Exploration	72	95	129	164
General and administrative	94	102	162	225
Transaction, reorganization and separation	10	6	37	10
Depreciation, depletion and amortization:				
Oil and gas property and equipment	387	562	918	1,169
Other assets	31	40	66	79
Asset retirement obligation accretion	27	26	54	53
Impairments	20	240	4,492	240
Financing costs, net	(34)	173	69	270
	1,012	1,770	6,857	3,262
NET INCOME (LOSS) BEFORE INCOME TAXES	(416)	(152)	(4,982)	13
Current income tax provision (benefit)	(27)	187	62	373
Deferred income tax benefit	(11)	(23)	(44)	(42)
NET LOSS INCLUDING NONCONTROLLING INTERESTS	(378)	(316)	(5,000)	(318)
Net income (loss) attributable to noncontrolling interest - Egypt	(11)	43	(162)	87
Net loss attributable to noncontrolling interest - Altus	—	(3)	(9)	(2)
Net income attributable to Altus Preferred Unit limited partners	19	4	37	4
NET LOSS ATTRIBUTABLE TO COMMON STOCK	$ (386)	$ (360)	$ (4,866)	$ (407)
NET LOSS PER COMMON SHARE:				
Basic	$ (1.02)	$ (0.96)	$ (12.88)	$ (1.08)
Diluted	$ (1.02)	$ (0.96)	$ (12.88)	$ (1.08)
WEIGHTED-AVERAGE NUMBER OF COMMON SHARES OUTSTANDING:				
Basic	378	377	378	376
Diluted	378	377	378	376
DIVIDENDS DECLARED PER COMMON SHARE	$0.025	$ 0.250	$ 0.050	$ 0.500

APACHE CORPORATION
PRODUCTION INFORMATION

	For the Quarter Ended			% Change		For the Six Months Ended	
	June 30, 2020	March 31, 2020	June 30, 2019	2Q20 to 1Q20	2Q20 to 2Q19	June 30, 2020	June 30, 2019
OIL VOLUME - Barrels per day							
United States	94,471	101,614	103,010	-7%	-8%	98,042	105,878
Egypt (1, 2)	79,839	73,178	83,761	9%	-5%	76,509	87,667
North Sea	47,016	55,262	50,055	-15%	-6%	51,139	52,279
International (1)	126,855	128,440	133,816	-1%	-5%	127,648	139,946
Total (1)	221,326	230,054	236,826	-4%	-7%	225,690	245,824
NATURAL GAS VOLUME - Mcf per day							
United States	518,156	597,842	594,238	-13%	-13%	557,999	668,858
Egypt (1, 2)	279,561	254,579	277,552	10%	1%	267,070	296,425
North Sea	52,612	67,278	50,121	-22%	5%	59,945	53,488
International (1)	332,173	321,857	327,673	3%	1%	327,015	349,913
Total (1)	850,329	919,699	921,911	-8%	-8%	885,014	1,018,771
NGL VOLUME - Barrels per day							
United States	69,759	81,381	61,974	-14%	13%	75,570	60,428
Egypt (1, 2)	909	918	898	-1%	1%	914	1,023
North Sea	1,733	2,135	1,673	-19%	4%	1,934	1,748
International (1)	2,642	3,053	2,571	-13%	3%	2,848	2,771
Total (1)	72,401	84,434	64,545	-14%	12%	78,418	63,199
BOE per day							
United States	250,589	282,636	264,024	-11%	-5%	266,612	277,782
Egypt (1, 2)	127,342	116,525	130,917	9%	-3%	121,934	138,094
North Sea	57,517	68,610	60,082	-16%	-4%	63,064	62,942
International (1)	184,859	185,135	190,999	0%	-3%	184,998	201,036
Total (1)	435,448	467,771	455,023	-7%	-4%	451,610	478,818
Total excluding noncontrolling interests	393,098	428,588	411,345	-8%	-4%	410,844	432,740

(1) Includes net production volumes attributed to our noncontrolling partner in Egypt below:

Oil (b/d)	26,609	24,598	27,939			25,604	29,239
Gas (Mcf/d)	92,625	85,672	92,639			89,148	98,990
NGL (b/d)	303	306	299			304	341
BOE per day	42,350	39,183	43,678	8%	-3%	40,766	46,078

(2) Egypt Gross Production

Oil (b/d)	171,897	183,627	198,534			177,762	201,245
Gas (Mcf/d)	642,003	655,410	729,378			648,706	742,474
NGL (b/d)	1,649	1,782	1,840			1,715	1,952
BOE per day	280,547	294,644	321,937	-5%	-13%	287,595	326,943

APACHE CORPORATION
ADJUSTED PRODUCTION INFORMATION

Adjusted production excludes certain items that management believes affect the comparability of operating results for the periods presented. Adjusted production excludes production attributable to 1) noncontrolling interest in Egypt and 2) Egypt tax barrels. Management uses adjusted production to evaluate the company’s operational trends and performance and believes it is useful to investors and other third parties.

	For the Quarter Ended			% Change		For the Six Months Ended	
	June 30, 2020	March 31, 2020	June 30, 2019	2Q20 to 1Q20	2Q20 to 2Q19	June 30, 2020	June 30, 2019
OIL VOLUME - Barrels per day							
United States	94,471	101,614	103,010	-7%	-8%	98,042	105,878
Egypt	54,469	44,491	44,261	22%	23%	49,480	46,281
North Sea	47,016	55,262	50,055	-15%	-6%	51,139	52,279
International	101,485	99,753	94,316	2%	8%	100,619	98,560
Total	195,956	201,367	197,326	-3%	-1%	198,661	204,438
NATURAL GAS VOLUME - Mcf per day							
United States	518,156	597,842	594,238	-13%	-13%	557,999	668,858
Egypt	186,387	161,536	160,306	15%	16%	173,962	170,655
North Sea	52,612	67,278	50,121	-22%	5%	59,945	53,488
International	238,999	228,814	210,427	4%	14%	233,907	224,143
Total	757,155	826,656	804,665	-8%	-6%	791,906	893,001
NGL VOLUME - Barrels per day							
United States	69,759	81,381	61,974	-14%	13%	75,570	60,428
Egypt	607	611	531	-1%	14%	609	604
North Sea	1,733	2,135	1,673	-19%	4%	1,934	1,748
International	2,340	2,746	2,204	-15%	6%	2,543	2,352
Total	72,099	84,127	64,178	-14%	12%	78,113	62,780
BOE per day							
United States	250,589	282,636	264,024	-11%	-5%	266,612	277,782
Egypt	86,140	72,025	71,510	20%	20%	79,083	75,327
North Sea	57,517	68,610	60,082	-16%	-4%	63,064	62,942
International	143,657	140,635	131,592	2%	9%	142,147	138,269
Total	394,246	423,271	395,616	-7%	0%	408,759	416,051

APACHE CORPORATION
PRICE INFORMATION

	For the Quarter Ended			For the Six Months Ended	
	June 30, 2020	March 31, 2020	June 30, 2019	June 30, 2020	June 30, 2019
AVERAGE OIL PRICE PER BARREL					
United States	$23.02	$46.32	$57.25	$35.09	$53.90
Egypt	25.80	49.97	68.60	37.36	65.36
North Sea	31.55	49.66	68.43	41.94	66.35
International	27.86	49.83	68.54	39.22	65.73
Total	25.77	48.31	63.71	37.44	60.65
AVERAGE NATURAL GAS PRICE PER MCF					
United States	$ 1.13	$ 0.70	$ 0.55	$ 0.90	$ 1.26
Egypt	2.73	2.83	2.80	2.78	2.82
North Sea	1.43	3.17	3.99	2.41	5.18
International	2.53	2.90	2.98	2.71	3.18
Total	1.68	1.47	1.41	1.57	1.92
AVERAGE NGL PRICE PER BARREL					
United States	$ 7.81	$ 9.59	$13.57	$ 8.77	$15.96
Egypt	20.97	31.70	32.90	26.36	35.56
North Sea	20.35	36.53	33.67	29.29	37.27
International	20.57	35.08	33.40	28.35	36.64
Total	8.28	10.51	14.37	9.48	16.87

APACHE CORPORATION
SUPPLEMENTAL FINANCIAL INFORMATION
(Unaudited)
(In millions)

SUMMARY EXPLORATION EXPENSE INFORMATION

	For the Quarter Ended June 30,		For the Six Months Ended June 30,	
	2020	2019	2020	2019
Unproved leasehold impairments	$ 31	$ 39	$ 50	$ 62
Dry hole expense	23	18	47	28
Geological and geophysical expense	4	18	7	36
Exploration overhead and other	14	20	25	38
	$ 72	$ 95	$129	$164

SUMMARY CASH FLOW INFORMATION

	For the Quarter Ended June 30,		For the Six Months Ended June 30,	
	2020	2019	2020	2019
Net cash provided by operating activities	$ 84	$ 856	$ 586	$ 1,454
Additions to upstream oil and gas property	(329)	(676)	(841)	(1,420)
Additions to Altus gathering, processing, and transmission facilities	(6)	(127)	(25)	(246)
Altus equity method interests	(71)	(320)	(154)	(438)
Proceeds from sale of oil and gas properties	—	238	126	247
Other, net	(2)	(9)	(23)	25
Net cash used in investing activities	$ (408)	$ (894)	$(917)	$(1,832)
Debt borrowings and payments, net	51	(170)	301	(11)
Altus credit facility borrowings	25	—	97	—
Distributions to noncontrolling interest - Egypt	(8)	(57)	(40)	(164)
Redeemable noncontrolling interest - Altus Preferred Unit limited partners	—	611	—	611
Dividends paid	(10)	(94)	(104)	(188)
Other	(27)	(30)	(35)	(35)
Net cash provided by financing activities	$ 31	$ 260	$ 219	$ 213

SUMMARY BALANCE SHEET INFORMATION

	June 30, 2020	December 31, 2019
Cash and cash equivalents	$ 135	$ 247
Other current assets	1,523	1,714
Property and equipment, net	9,344	14,158
Other assets	1,997	1,988
Total assets	$12,999	$ 18,107
Current debt - Apache *	$ 294	$ 1
Current debt - Altus	—	10
Current liabilities	1,416	1,844
Long-term debt - Apache *	8,030	8,159
Long-term debt - Altus	493	396
Deferred credits and other noncurrent liabilities	2,810	2,677
Redeemable noncontrolling interest - Altus Preferred Unit limited partners	592	555
Apache shareholders' equity (deficit)	(1,635)	3,255
Noncontrolling interest - Egypt	935	1,137
Noncontrolling interest - Altus	64	73
Total Liabilities and equity	$12,999	$ 18,107
Common shares outstanding at end of period	377	377

* Excludes Altus

APACHE CORPORATION
NON-GAAP FINANCIAL MEASURES
(In millions, except per share data)

Reconciliation of Net cash provided by operating activities to Adjusted EBITDAX

Management believes EBITDAX, or earnings before income tax expense, interest expense, depreciation, amortization and exploration expense is a widely accepted financial indicator, and useful for investors, to assess a company's ability to incur and service debt, fund capital expenditures, and make distributions to shareholders. We define adjusted EBITDAX, a non-GAAP financial measure, as EBITDAX adjusted for certain items presented in the accompanying reconciliation. Management uses adjusted EBITDAX to evaluate our ability to fund our capital expenditures, debt services and other operational requirements and to compare our results from period to period by eliminating the impact of certain items that management does not consider to be representative of the Company's on-going operations. Management also believes adjusted EBITDAX facilitates investors and analysts in evaluating and comparing EBITDAX from period to period by eliminating differences caused by the existence and timing of certain operating expenses that would not otherwise be apparent on a GAAP basis. However, our presentation of adjusted EBITDAX may not be comparable to similar measures of other companies in our industry.

	For the Quarter Ended			For the Six Months Ended	
	June 30, 2020	March 31, 2020	June 30, 2019	June 30, 2020	2019
Net cash provided by operating activities	$ 84	$ 502	$ 856	$586	$1,454
Adjustments:					
Exploration expense other than dry hole expense and unproved leasehold impairments	18	14	38	32	74
Current income tax provision (benefit)	(27)	89	187	62	373
Other adjustments to reconcile net income to net cash provided by operating activities	(22)	8	(13)	(14)	(22)
Changes in operating assets and liabilities	66	21	(178)	87	(40)
Financing costs, net	106	103	98	209	195
Transaction, reorganization & separation costs	10	27	6	37	10
Adjusted EBITDAX (Non-GAAP)	$235	$ 764	$ 994	$999	$2,044

Reconciliation of Income attributable to common stock to Adjusted earnings

Our presentation of adjusted earnings and adjusted earnings per share are non-GAAP measures because they exclude the effect of certain items included in Income Attributable to Common Stock. Management believes that adjusted earnings and adjusted earnings per share provides relevant and useful information, which is widely used by analysts, investors and competitors in our industry as well as by our management in assessing the Company's operational trends and comparability of results to our peers.

Management uses adjusted earnings and adjusted earnings per share to evaluate our operating and financial performance because it eliminates the impact of certain items that management does not consider to be representative of the Company's on-going business operations. As a performance measure, adjusted earnings may be useful to investors in facilitating comparisons to others in the Company's industry because certain items can vary substantially in the oil and gas industry from company to company depending upon accounting methods, book value of assets, capital structure and asset sales and other divestitures, among other factors. Management believes excluding these items facilitates investors and analysts in evaluating and comparing the underlying operating and financial performance of our business from period to period by eliminating differences caused by the existence and timing of certain expense and income items that would not otherwise be apparent on a GAAP basis. However, our presentation of adjusted earnings and adjusted earnings per share may not be comparable to similar measures of other companies in our industry.

	For the Quarter Ended June 30, 2020				For the Quarter Ended June 30, 2019			
	Before Tax	Tax Impact	After Tax	Diluted EPS	Before Tax	Tax Impact	After Tax	Diluted EPS
Net loss including noncontrolling interests (GAAP)	$ (416)	$ 38	$(378)	$ (1.00)	$ (152)	$ (164)	$(316)	$ (0.84)
Income (loss) attributable to noncontrolling interests	(17)	6	(11)	(0.03)	80	(40)	40	0.11
Income attributable to Altus preferred unit limited partner	19	—	19	0.05	4	—	4	0.01
Net loss attributable to common stock	(418)	32	(386)	(1.02)	(236)	(124)	(360)	(0.96)
Adjustments:*								
Asset impairments	51	(6)	45	0.12	279	(59)	220	0.58
Noncontrolling interest & tax barrel impact on Egypt adjustments	(7)	—	(7)	(0.02)	—	—	—	—
Valuation allowance and other tax adjustments	—	64	64	0.17	—	114	114	0.31
(Gain)/Loss on extinguishment of debt	(140)	29	(111)	(0.29)	75	(16)	59	0.16
Unrealized derivative instrument losses, net	138	(30)	108	0.29	21	(4)	17	0.04
Noncontrolling interest on Altus preferred units embedded derivative	(2)	1	(1)	(0.01)	—	—	—	—
Transaction, reorganization & separation costs	10	(3)	7	0.02	6	(1)	5	0.01
Gain on divestitures, net	—	—	—	—	(17)	3	(14)	(0.03)
Contract termination charges	—	—	—	—	—	—	—	—
Adjusted earnings (Non-GAAP)	$ (368)	$ 87	$(281)	$ (0.74)	$ 128	$ (87)	$ 41	$ 0.11

	For the Six Months Ended June 30, 2020				For the Six Months Ended June 30, 2019			
	Before Tax	Tax Impact	After Tax	Diluted EPS	Before Tax	Tax Impact	After Tax	Diluted EPS
Net loss including noncontrolling interests (GAAP)	$(4,982)	$ (18)	$(5,000)	$(13.23)	$ 13	$ (331)	$(318)	$ (0.84)
Income (loss) attributable to noncontrolling interest	(161)	(10)	(171)	(0.45)	165	(80)	85	0.23
Income attributable to Altus preferred unit limited partner	37	—	37	0.10	4	—	4	0.01
Net loss attributable to common stock	(4,858)	(8)	(4,866)	(12.88)	(156)	(251)	(407)	(1.08)
Adjustments:*								
Asset impairments	4,542	(844)	3,698	9.79	302	(64)	238	0.62
Noncontrolling interest & tax barrel impact on Egypt adj	(170)	(7)	(177)	(0.47)	—	—	—	—
Valuation allowance and other tax adjustments	—	932	932	2.46	—	145	145	0.39

(Gain)/Loss on extinguishment of debt	(140)	29	(111)	(0.29)	75	(16)	59	0.16
Unrealized derivative instrument losses, net	241	(51)	190	0.50	66	(14)	52	0.14
Noncontrolling interest on Altus preferred units embedded derivative	(15)	4	(11)	(0.03)	—	—	—	—
Transaction, reorganization & separation costs	37	(9)	28	0.07	10	(2)	8	0.02
Gain on divestitures, net	(25)	8	(17)	(0.04)	(20)	4	(16)	(0.04)
Contract termination charges	3	(1)	2	0.01	—	—	—	—
Adjusted Earnings (Non-GAAP)	$ (385)	$ 53	$ (332)	$ (0.88)	$ 277	$ (198)	$ 79	$ 0.21

* The income tax effect of the reconciling items are calculated based on the statutory rate of the jurisdiction in which the discrete item resides.

APACHE CORPORATION
NON-GAAP FINANCIAL MEASURES
(In millions)

Reconciliation of Costs incurred to Upstream capital investment

Management believes the presentation of upstream capital investments is useful for investors to assess Apache's expenditures related to our upstream capital activity. We define capital investments as costs incurred for oil and gas activities, adjusted to exclude asset retirement obligation revisions and liabilities incurred, capitalized interest, and certain exploration expenses, while including amounts paid during the period for abandonment and decommissioning expenditures. Upstream capital expenditures attributable to a one-third noncontrolling interest in Egypt are also excluded. Management believes this provides a more accurate reflection of Apache's cash expenditures related to upstream capital activity and is consistent with how we plan our capital budget.

	For the Quarter Ended June 30,		For the Six Months Ended June 30,	
	2020	2019	2020	2019
Costs incurred in oil and gas property:				
Acquisitions				
Proved	$ 1	$ —	$ 7	$ —
Unproved	2	22	3	41
Exploration and development	266	639	756	1,294
Total Costs incurred in oil and gas property	$269	$661	$766	$1,335
Reconciliation of Costs incurred to Upstream capital investment:				
Total Costs incurred in oil and gas property	$269	$661	$766	$1,335
Asset retirement obligations settled vs. incurred - oil and gas property	5	9	13	19
Capitalized interest	—	(8)	—	(16)
Exploration seismic and administration costs	(18)	(38)	(32)	(74)
Less noncontrolling interest - Egypt	(40)	(35)	(89)	(78)
Total Upstream capital investment	$216	$589	$658	$1,186

Reconciliation of Net cash provided by operating activities to Cash flows from operations before changes in operating assets and liabilities

Cash flows from operations before changes in operating assets and liabilities is a non-GAAP financial measure. Apache uses it internally and provides the information because management believes it is useful for investors and widely accepted by those following the oil and gas industry as a financial indicator of a company's ability to generate cash to internally fund exploration and development activities, fund dividend programs, and service debt. It is also used by research analysts to value and compare oil and gas exploration and production companies and is frequently included in published research when providing investment recommendations. Cash flows from operations before changes in operating assets and liabilities, therefore, is an additional measure of liquidity but is not a measure of financial performance under GAAP and should not be considered as an alternative to cash flows from operating, investing, or financing activities.

	For the Quarter Ended			For the Six Months Ended	
	June 30, 2020	March 31, 2020	June 30, 2019	June 30, 2020	2019
Net cash provided by operating activities	$ 84	$ 502	$ 856	$586	$1,454
Changes in operating assets and liabilities	66	21	(178)	87	(40)
Cash flows from operations before changes in operating assets and liabilities	$ 150	$ 523	$ 678	$673	$1,414

Exhibit 42

Corrected Transcript

30-Jul-2020

Apache Corp. (APA)

Q2 2020 Earnings Call

CORPORATE PARTICIPANTS

Gary T. Clark
Vice President-Investor Relations, Apache Corp.

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

Stephen J. Riney
Chief Financial Officer & Executive Vice President, Apache Corp.

David A. Pursell
Executive Vice President, Development, Apache Corp.

OTHER PARTICIPANTS

Doug Leggate
Analyst, Bank of America Merrill Lynch

Michael Stephen Scialla
Analyst, Stifel, Nicolaus & Co., Inc.

Bob Brackett
Analyst, Sanford C. Bernstein & Co. LLC

Charles Meade
Analyst, Johnson Rice & Co. LLC

Jeanine Wai
Analyst, Barclays Capital, Inc.

John Freeman
Analyst, Raymond James & Associates, Inc.

Gail Nicholson
Analyst, Stephens, Inc.

Arun Jayaram
Analyst, JPMorgan Securities LLC

Scott Hanold
Analyst, RBC Capital Markets LLC

Brian Singer
Analyst, Goldman Sachs & Co. LLC

Richard Tullis
Analyst, Capital One Securities, Inc.

Neal Dingmann
Analyst, SunTrust Robinson Humphrey, Inc.

Leo Mariani
Analyst, KeyBanc Capital Markets, Inc.

David Adam Deckelbaum
Analyst, Cowen & Co. LLC

David Martin Heikkinen
Founder & Chief Executive Officer, Heikkinen Energy Advisors LLC

Paul Y. Cheng
Analyst, Scotia Capital (USA), Inc.

Jeffrey L. Campbell
Analyst, Tuohy Brothers Investment Research, Inc.

MANAGEMENT DISCUSSION SECTION

Operator: Ladies and gentlemen, thank you for standing by, and welcome to the Apache Corporation Second Quarter 2020 Earnings Announcement Webcast. [Operator Instructions] I would now like to introduce your host for today's conference Mr. Gary Clark, Vice President of Investor Relations. You may begin.

Gary T. Clark

Vice President-Investor Relations, Apache Corp.

Good morning, and thank you for joining us on Apache Corporation's second quarter financial and operational results conference call. We will begin the call with an overview by CEO and President, John Christmann. Steve Riney, Executive Vice President and CFO, will then summarize our second quarter financial performance. Clay Bretches, Executive Vice President of Operations and Dave Pursell, Executive Vice President, Development, will also be available on the call to answer questions.

Our prepared remarks will be approximately 15 minutes in length with the remainder of the hour allotted for Q&A. In conjunction with yesterday's press release, I hope you have had the opportunity to review our second quarter financial and operational supplement which can be found on our Investor Relations website at investor.apachecorp.com.

Please note that we may discuss certain non-GAAP financial measures. A reconciliation of the differences between these non-GAAP financial measures and the most directly comparable GAAP financial measures can be found in the supplemental information provided on our website. Consistent with previous reporting practices, adjusted production numbers cited in today's call are adjusted to exclude non-controlling interest in Egypt and Egypt tax barrels.

Finally, I'd like to remind everyone that today's discussions will contain forward-looking estimates and assumptions based on our current views and reasonable expectations. However, a number of factors could cause actual results to differ materially from what we discuss today. A full disclaimer is located with the supplemental information on our website.

And with that, I will turn the call over to John.

John J. Christmann IV

President, Chief Executive Officer & Director, Apache Corp.

Good morning, and thank you for joining us. For the last several months, the world and the global E&P industry have been facing one of the most challenging environments in recent history. Apache is responding with decisive actions designed to protect our people, our assets, our investors and the communities in which we operate. And I want to take this opportunity to thank the many Apache employees and contractors for their hard work and dedication in these tough times.

In my prepared remarks this morning, I will discuss the progress we made during the second quarter and review our key objectives and capital priorities going forward.

I'd like to begin with a brief update on our response to the COVID-19 pandemic. Apache moved quickly to implement a wide range of fit-for-purpose protocols to ensure a safe and productive work environment in both our

onshore and offshore operations. Thankfully, we have experienced a relatively small number of COVID-19 cases and have incurred no material operational disruptions beyond our intentional production curtailments.

We are prepared to maintain our current work model for as long as necessary. Since the onset of the pandemic, we have been listening and responding to the specific needs of the communities in which we work and live. Apache has donated PPE and critical medical equipment to hospitals and first responders, as well as supporting food banks, long distance learning initiatives and shelters for women and children.

From an operational and financial perspective, during the second quarter, we executed our planned activity reductions on schedule and delivered upstream CapEx well below guidance of $230 million. For the full year, we are now tracking toward the lower end of our capital guidance range of $1 billion to $1.2 billion.

The majority of our organizational redesign has been implemented, achieving combined run rate, LOE and overhead savings of more than $300 million as planned. Net of severance and restructuring costs, actual cash savings realized in 2020 are estimated to be approximately $225 million. Through these and other actions, we have reduced our free cash flow breakeven oil price to be around $30 per barrel on a forward-looking basis. This allows us to protect our current financial position and enables positive free cash flow in the current price environment.

And in Block 58 Offshore Suriname, during the second quarter we submitted a plan of appraisal for our first discovery mockup, announced our second discovery at Sapakara and spudded our third exploration well, Kwaskwasi, the results of which we announced yesterday in conjunction with our earnings release. We are thrilled with the results from the Kwaskwasi-1 exploration well. This is the best well we've drilled in the basin to date, with the highest net pay and the best quality reservoirs.

While we have a lot more work to do, a discovery of this quality and magnitude merits a pace of evaluation that enables the option of accelerated first production. Following Kwaskwasi, the Noble Sam Croft drillship will move to the fourth well in our 2020 exploration program, Keskesi, after which Apache will transition operatorship of the block to our partner Total.

Turning now to the curtailment program, we have returned our North Sea and Alpine High volumes to production along with a portion of curtailed oil volumes in the Permian. We anticipate that several thousand barrels of higher cost Permian oil production may remain offline for the rest of 2020. Apache is currently running one exploratory rig in Suriname, five rigs in Egypt and one floating rig and one platform rig in the North Sea. We intend to maintain this activity set for the remainder of the year if commodity prices do not deteriorate significantly.

At this time in the Permian Basin, we have no drilling or completions activity and no plans to complete our DUCs for the remainder of the year. As we look at the second half of 2020 into the long term, our key objectives remain unchanged despite the extreme price volatility. We will budget conservatively and direct free cash flow on a priority basis to debt reduction, maintain a balanced and diversified portfolio and prioritize investment for long-term returns over production growth.

We have spoken frequently about our priority ranking for capital deployment within the portfolio and our thoughts on this are worth reiterating. At the top of the list is Suriname, which will continue to receive priority funding for both exploration and appraisal activity. Under the terms of our joint venture, the incremental cost to Apache associated with appraisal and ultimately development should be very manageable.

Our second priority is Egypt where the PSC structure offers more stable returns in relatively low and more volatile oil price environments. Following that, we should look to complete our DUCs in the Permian Basin and resume drilling with a second platform rig in the North Sea.

And finally, while our Permian operations have been delivering highly competitive economics within the basin, other areas within our portfolio offer more attractive investment options in a capital-constrained environment. Therefore, we don't envision returning rigs to the Permian Basin unless oil prices recover well into the $50s.

We have always stated that our best hedge against price volatility is prudent and responsive management of the capital program. To the extent oil prices are sustained at or below $50 per barrel WTI, we do not anticipate a material change in our annual capital budget from the current rate of around $1 billion. For oil prices significantly below $50, capital spending is more likely to be reduced from the $1 billion mark. If oil prices rise above $50, we will be very measured with our capital increases and the first call on that incremental free cash flow will be return to investors initially with debt reduction.

I'd like to close by summarizing Apache's approach to managing the unprecedented challenges thus far in 2020. We implemented successful COVID-19 operating protocols and work-from-home procedures and helped ease the burden of the pandemic on our host communities in numerous ways. We responded to the sudden price drop by quickly limiting cash outflows to protect our balance sheet. This included a significant reduction in capital, dividends and overhead and operating costs. These, along with other actions, have enabled us to lower our free cash flow breakeven such that we now have good visibility to debt reduction.

Operationally, we have preserved optionality to reactivate our curtailed production, development programs, and other investment opportunities when appropriate. And we have successfully advanced our exploration program in Suriname. Through these and other actions, particularly the successful implementation of our corporate redesign, we entered the second half of 2020 a very focused and streamlined organization. The benefits of our diversified portfolio are more evident now than ever as we flex capital towards our international operations. Together, with our world class position in Suriname, Apache offers a truly differentiated investment opportunity within an industry that has come under tremendous pressure.

I would like to again thank all the Apache employees for their commitment, resilience, hard work and flexibility as we successfully navigate these challenging times.

And with that, I will turn the call over to Steve Riney.

Stephen J. Riney

Chief Financial Officer & Executive Vice President, Apache Corp.

Thank you, John. On today's call, I will review second quarter 2020 results, discuss progress on our cost saving initiatives and provide commentary on our free cash flow outlook and debt management efforts.

As noted in our news release issued yesterday, under generally accepted accounting principles, Apache reported a second quarter 2020 consolidated net loss of $386 million or $1.02 per diluted common share. These results include items that are outside of core earnings, the most significant of which are an unrealized loss on derivatives, a tax valuation allowance and asset impairments, partially offset by a gain on the repurchase of outstanding debt. Excluding these and other smaller items, the adjusted loss was $281 million, or $0.74 per share.

Adjusted production decreased 70% from the prior quarter, primarily driven by shut-ins and production curtailments of approximately 19,000 BOEs per day at Alpine High and production curtailments of 10,000 BOEs

per day in the North Sea and 6,000 BOEs per day for other operations in the Permian. Partially offsetting this was increased Egypt cost recovery volumes due to the lower oil prices in the quarter.

Apache's second quarter average realized price on a BOE basis fell 39% from the prior quarter with oil and NGL prices down materially. International oil price realizations were notably weak as actual Brent realizations dislocated from the published benchmark price. This discount was driven by unprecedented excess supply on the market, resulting in unusual competitive pricing dynamics.

Consequently, second quarter international oil realizations averaged around $5.50 per barrel below the benchmark, which we do not customarily experience. So far in the third quarter, Brent pricing has reconnected with the benchmark and we do not currently anticipate this changing.

Turning now to our cost savings initiatives, we entered 2020 with a goal of reducing annualized overhead and LOE costs by at least $150 million. With the price downturn in March, we took quick action to double that goal to at least $300 million. We have since fully achieved this target and then some. Roughly two thirds of the targeted savings are coming from overhead reductions and one third from direct LOE reductions. These are sustainable cost reductions and they are showing up in multiple places on our financial statements.

So let me provide some detail. Of the roughly $200 million of annualized overhead cash cost reductions, approximately $100 million will show up as reduced capital investment. $20 million will come in the form of reductions in LOE and exploration expense and approximately $80 million will show up in lower G&A expense. So our underlying G&A expense, which in the recent past typically ran about $100 million per quarter, should now run around $80 million per quarter.

During the first quarter of 2020, you will recall we had a nearly $30 million reduction in G&A expense caused by the mark-to-market effect on the share-based compensation plan associated with the significant negative movement in our stock price. During the second quarter, this impact partially reversed, generating a $19 million increase in G&A expense. As a result, second quarter G&A expense was $94 million.

Turning now to LOE, we have eliminated approximately $100 million of direct LOE costs on an annualized basis. In addition to these sustainable LOE reductions, we are also seeing cost reductions associated with production curtailments and deferred workovers as well as the deferral of certain other nonessential activities. While these actions reduce costs in the near term, they are not sustainable, so we expect at least a portion of them to return at some point in the future.

As we have previously noted, one of our key long-term objectives is debt reduction. Let me share two views on this objective as we look at the second quarter. With respect to long-term debt, we took the opportunity to repurchase bonds at significant discounts when the debt market came under pressure. In aggregate, during the second quarter, we repurchased $410 million of face value debt for $263 million, reducing aggregate long-term debt by $147 million. The repurchased debt had an average remaining term of approximately 20 years, and at the purchase price, had an average yield of 9%, making this a very attractive investment.

Another view of debt is through the borrowings on our revolver. Between the negative cash flow impacts of the extremely low price environment and the $263 million of bond repurchases, we ended the quarter with $565 million outstanding on the revolver. With an improving second half price outlook, combined with lower capital investment and reduced operating and overhead costs, we anticipate generating positive free cash flow in the second half, and using it to reduce borrowings on the revolver.

Before wrapping up, I'd like to note that we did issue third quarter guidance yesterday in our financial and operational supplement on our website which covers our outlook for capital investment and production, as well as a number of expense items.

In summary, although it was a very challenging quarter from a price and cash flows perspective, we took significant actions to reduce our cost structure, protect the balance sheet and retain asset value for the future. To the extent WTI oil prices remain above $30 per barrel, we look forward to generating free cash flow in the second half of 2020 and using that to reduce leverage.

And with that, I will turn the call over to the operator for Q&A.

QUESTION AND ANSWER SECTION

Operator: [Operator Instructions] Our first question comes from Doug Leggate with Bank of America. Doug, your line is open.

Doug Leggate
Analyst, Bank of America Merrill Lynch

Q

Sorry, guys. I was on mute. I couldn't get my mute button to go off. I apologize. Good morning, everyone. John, this is also a great day for your stock. And congratulations on the latest discovery in Suriname. I'm obviously going focus my two questions on that if I may. So my first one is your comment in the press release about this deserts, perhaps, the option of an accelerated first production. My question is, what influence does Apache have over that? How aligned is Total and what are the parameters within the contract that could get you to that? And I guess what I'm really aiming for is, would you consider an early production system here? And I've got a follow-up.

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

Well, Doug, thank you, first of all. I think in the end it's just going to boil down to the quality of the well and the rock in the play. When you step back and look, Block 58's 1.4 million acres. To put it in perspective, it's over 250 Gulf of Mexico blocks. We've now drilled three wells in three different fairways. And I use that context to help you understand why you can have three very large fairways. We're going to be moving to another one with Keskesi once we conclude operations.

The comments in the press release kind of speak for themselves with where we sit. I think that our partner is also excited. We've done some things in the Campanian with this well. We gained, collected some extra data. We're doing some things with an exploration well that you typically would not do, which helps us gain some insight into what we've got. And so we'll – in the end, it's going to boil down to us being aligned with our partner, and of course, aligned with Staatsolie and the government of Suriname in terms of the pace and moving it forward. But I think in the end, it's going to be the quality of the rock and the resource potential that's going to drive that.

Doug Leggate
Analyst, Bank of America Merrill Lynch

Q

Pardon my follow-up on this question John, but Total just don't seem to be communicating the same level of urgency, I guess, as your comment in the press release. So I just wonder if you could help us bridge the gap between, given that they're going to take over [indiscernible] (21:04).

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

Well, I think all my comment says is that it's of a quality that would look at an accelerated pace. I think in their press release today, they stated that there will be an appraisal and exploration program early next year to appraise our discovery. So I'll just leave it at that.

Doug Leggate
Analyst, Bank of America Merrill Lynch

Q

Okay. My follow up is also on Kwaskwasi and it's related to the deeper Santonian. Obviously, you did not disclose anything other than hydrocarbon reservoir. The last time we heard that expression it was gas condensate at Haimara in Guyana. So I'm just wondering if you can address some concerns out there as to what the hydrocarbon type is, why you didn't release APIs, what you know about scale. Just any other ways you can characterize that deeper horizon and I'll leave it there. Thank you.

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

Yeah, the thing I'll say is if you look at the first two wells, the Santonian has been more oily than the Campanian. So I will tell you, everything looks good here. We were at a position, because we had done some additional work in the upper zones and set pipe in the Campanian, that we had a lot of that, all that information. There is still more that we are collecting here. But we felt like we were at a position with the materiality that we should talk about it. I'll let Dave give a little more color on the Santonian there.

David A. Pursell
Executive Vice President, Development, Apache Corp.

A

Yeah thanks, John. So, Doug, John talked about some additional testing in the Campanian. So it's important from a timing perspective. We did some additional deeper investigation type testing. And it does two things for us. It gives us a composite flow capacity and allows us to see a little deeper in the reservoir than conventional flow testing allows. So we're through the Santonian. We have the conventional wireline logs collected.

Based on our experience with the mud logging and the open wireline logging on Maka, Sapakara and the Campanian in this well, we feel confident that we have oil in significant portion of the Santonian. So, we felt like we were fine with releasing. We still have work to do. We still have to collect fluids and pressures. We have core data to collect and we anticipate doing some of the additional deeper investigation testing on this interval. So I wouldn't read too much into the fact that we didn't release API gravities because we don't have those collected yet.

Doug Leggate
Analyst, Bank of America Merrill Lynch

Q

I understand. Well guys, congrats again, and I look forward to the next topic. Thanks.

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

Thank you.

Operator: Our next question comes from Mike Scialla with Stifel.

Michael Stephen Scialla
Analyst, Stifel, Nicolaus & Co., Inc.

Q

Yeah, good morning everybody, and congratulations as well. I was curious on Kwaskwasi, the results there, how those compared to expectations. Was there any indication from your seismic data that this well would have more than double the net pay of the other two?

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

Mike, first of all, thank you. I mean, when you look at the seismic, we knew Kwaskwasi was going be a prolific fairway as the other two were. It boils down a little bit about the depositional environment. I mean once again, we're in such a large area and these wells are so far apart, that you have to drill them to learn that. So I mean clearly it exceeded what had been pre-drill. but we knew there was that kind of potential. And there is the exciting thing about it is, is we've got a lot more of this block to explore. But clearly very excited about it.

Michael Stephen Scialla
Analyst, Stifel, Nicolaus & Co., Inc.

Q

Good. And then, Stephen, you mentioned about prioritizing or that you want to improve the balance sheet obviously. I was wondering how you would prioritize options there? Is it really just using free cash flow to pay down debt or any other options you're considering at this point?

Stephen J. Riney
Chief Financial Officer & Executive Vice President, Apache Corp.

A

Yeah, Mike, I think in a more typical environment, you'd see companies selling assets to strengthen the balance sheet to pay down debt. And I think it's clear that in the price environment we're in right now, that just doesn't work. And so for the most part, it is going to be the old fashioned way of retaining free cash flow, spending a little bit less on capital, which we all ought to be doing.

And that just means it will take some time to get the balance sheet in order unless there's a price spike or some, yeah, there will be the occasional one-off opportunities where you have a chance to do something to reduce debt, similar to what we did in the second quarter, with repurchasing some debt at a discount. And we'll take advantage of those from time to time.

But I do believe this is just a simple case of prioritizing, retaining free cash flow, and using it to pay down debt instead of spending it on capital to maybe achieve a different type of growth profile. Clearly for us, strengthening the balance sheet is going be much more important than growing production volume. And I think we're now approaching a period where we're going the be able to do that.

We've, as John mentioned in his prepared remarks, we're now capable of running free cash flow neutral at $30 WTI on a point-forward basis for the rest of this year, with the CapEx budget where it is, with the dividend cut, the overhead cuts, the LOE cuts, some of the other things that we've done. We have no intention of raising the capital budget for this year. And that's what we'll do. To the extent that that oil price exceeds $30 WTI, we'll use any excess free cash flow that that generates to reduce debt.

Michael Stephen Scialla
Analyst, Stifel, Nicolaus & Co., Inc.

Q

Very good. Thank you.

Operator: Our next question comes from Bob Brackett with Bernstein Research.

Bob Brackett
Analyst, Sanford C. Bernstein & Co. LLC

Q

Hi. Good morning. I'm intrigued a bit by the comments around doing some things with an exploration well that you wouldn't typically do and the deeper investigation type testing. Are you performing a mini drill stem test out there and are there any rates to report?

David A. Pursell
Executive Vice President, Development, Apache Corp.

A

Yeah, Bob, this is Dave Pursell. Good try. It's something that would be between. If you want to call it a mini drill stem test, that would be a reasonable characterization. It's something between a full drill stem test and what you would typically get from a fluid sampling operation. So again, what we're getting from this is composite flow capacity.

Instead of a point permeability measurement from a core sample, we're getting a composite flow capacity. And then another benefit is some deeper investigation for pressures into the reservoir. So we're still evaluating that data. But that's what we're doing. And again, we anticipate performing those tests in the Santonian as well.

Bob Brackett
Analyst, Sanford C. Bernstein & Co. LLC

Q

Yes. That's clear. Another question, given the thickness of this recent discovery, what drove the sequencing of the overall exploration campaign, and what might that tell us about the fourth well?

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

I mean, I think when you step back and look, as we said, we had multiple fairways. I think they're – and you look at the size and think about this, it's equivalent 250 Gulf of Mexico blocks, so moving across there. A lot of it has to do just with how things were deposited. But, we've got a full another fairway that it will be testing. So we're anxious to move over and see. But everything looks really good on the seismic. So we're anxious to move on to Keskesi after Kwaskwasi.

Bob Brackett
Analyst, Sanford C. Bernstein & Co. LLC

Q

I appreciate it.

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

Thank you.

Operator: Our next question comes from Charles Meade with Johnson Rice.

Charles Meade
Analyst, Johnson Rice & Co. LLC

Q

Good morning, John, to you and your whole team there.

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

Good morning Charles.

Charles Meade
Analyst, Johnson Rice & Co. LLC

Q

I'm going to ask another question on really the headline that everyone's focused on, the thickness of the pay that you guys found with this well. I'm curious, is there anything going on with either the dip of these formations or perhaps structurally that's some kind of mitigating factor for that thickness you announced? Or is this more the case where you guys just really found a thick stack of pancakes here?

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

I would just say it's really more depositionally. There's nothing tricky with it. Geology's pretty level out here. So it's very exciting. I think it just gets to the quality in the cretaceous here, both with the Campanian and the Santonian. So as we've said, there are other play types that we are still looking forward to testing. The Turonian is a target we had at Maka.

There's more to do. We've really, with the Campanian and Santonian, we've really only fully starting to evaluate two of the play types. We think there's seven or eight, so there's multiple targets. So a lot of exploration to do. And obviously, we got a lot of appraisal work to do on these first three discoveries.

Charles Meade
Analyst, Johnson Rice & Co. LLC

Q

Well, John, you anticipated my follow-up question on the Turonian. Because I remember back, you guys certainly have plenty to say grace over here, but going back to that first well, the Maka well, that you guys had some encouragement with the Turonian. So is that something that we should anticipate you guys, are you going to maybe test with your next well, or is that something that's where you found enough in the Campanian and Santonian that that's kind of receded into 2021 or beyond?

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

Well, really just the timing of how, if you look, Charles, we're really still moving across one direction across this block with these first four wells. We haven't even started to move the other direction, which would be north and south. So, Keskesi obviously moved to the other side of Sapakara. So we'll talk about that with the future exploration wells.

Charles Meade
Analyst, Johnson Rice & Co. LLC

Q

Got it. Thank you for that color, John.

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

Thank you.

Operator: Our next question comes from Jeanine Wai with Barclays.

Jeanine Wai
Analyst, Barclays Capital, Inc.

Q

Hi. Good morning, everyone.

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

Good morning.

Jeanine Wai
Analyst, Barclays Capital, Inc.

Q

Good morning. I've got two questions on Suriname, shocking. But I guess my first question is just on the reservoir quality and the second is just on the accelerated first production commentary. So based on what you've seen so far from the Kwaskwasi well, can you provide a little more color on what makes the reservoir one of the best quality reservoirs that you've ever seen in the basins? And is it primarily just the net feet of pay or are there other characteristics that you can elaborate on?

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

I'd just say in general, it's better. It's better if you look at the one, net feet of pay both in the Santonian and in the Campanian are greater than we had in the first two wells combined. So that's one element, but I'll also tell you the quality looks fantastic. So at this point, that's all we're going to say about it.

Jeanine Wai
Analyst, Barclays Capital, Inc.

Q

Okay. I can appreciate that. And then my follow-up question. In terms of the potential for accelerated first production, relative to the current plan, which to our understanding I think was something around four development wells and four exploration wells a year. Is the thought that maybe you could shift some exploration CapEx to development CapEx? Or do you envision doing more than the four plus four wells? I know it's still early but I'm also not sure if there's anything in the PSC that allows for some timing flexibility.

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

Yeah, I mean, what I would say is I don't know where the four appraisal or four development wells came from. We're drilling four exploration wells this year. Under the terms of our joint venture, us and our partner can each propose four exploration wells, so there could be eight going forward. What we've stated is, is there will be both an appraisal program and an exploration program in 2021. And we plan to try to get started as early as we can. So clearly, the comment is, is with what we've got and some of the things we're doing here, this is of a quality and magnitude that it would warrant trying to look at could it be accelerated, is all we're saying.

Jeanine Wai
Analyst, Barclays Capital, Inc.

Q

Okay. Great. Thank you very much.

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp. A

Thank you.

Operator: Our next question comes from John Freeman with Raymond James.

John Freeman
Analyst, Raymond James & Associates, Inc. Q

Hi, guys.

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp. A

Good morning, John.

John Freeman
Analyst, Raymond James & Associates, Inc. Q

So I wanted to focus on the capital allocation. You all have been pretty clear about the balance sheet being the first priority, and then kind of Suriname, Egypt, North Sea, Permian, sort of that order. And the slide that you all have got in your presentation sort of lays it out at different kind of price decks, how that capital gets allocated. And, John, you were very clear in your prepared remarks that it's going to take an oil price well over $50 to put a rig back to work in the Permian.

But I guess I'm curious, with sort of where the current strip is, which is just barely above $40, it's kind of right on the line there between if you'd do anything in the North Sea, if you would potentially draw down DUCs in the Permian. And I guess what I'm going towards is, with this continued success in Suriname and everything you all want to do there, and the continued run in Egypt, if maybe the gap has sort of widened between those two assets versus the other two, to where maybe – and oil price is just barely above $40, it maybe doesn't make sense maybe to put the capital at those last two relative to the others. Like is their part of the pie now getting bigger, I guess?

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp. A

Yeah, John, a really good question. I think the first thing I would say is, is in my prepared remarks, I laid out too that where the strip is today, CapEx probably comes down for the whole in 2021. And that's just because of how we prioritize things.

As it relates to the pie, Suriname, the way we structured our joint venture, it really doesn't change how much capital we have to put into Suriname. So clearly, it's just going to boil down to how much capital do we want to spend. And with where the strip sits today, I really think that the CapEx budget's going to come down because we're going to want to generate some free cash flow that can go towards reducing our debt.

John Freeman
Analyst, Raymond James & Associates, Inc. Q

Great. And then just the last question for me, with this latest result in Suriname and everything you're doing there, just internally relative to how you were thinking about the mix of kind of appraisal and exploration in Suriname next year, does this change that mix? I'm not telling you to give me the actual breakdown, because you haven't

probably determined that yet. But just does it change your thought process of how that mix would have been prior to this result?

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

It really doesn't because I mean we've been – I think we understand the potential there. Clearly, there's things you're going to want to try to move forward on an accelerated pace if we can. But we also have a very large block that we have to continue to explore. And so we're going to want to continue exploring. I think the exploration pace will be pretty similar to what it is today. And then it'll just be a function of what we need to do on the appraisal side with our partner.

John Freeman
Analyst, Raymond James & Associates, Inc.

Q

Thanks, John. I appreciate it. And congrats.

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

Thank you.

Operator: Our next question comes from Gail Nicholson with Stephens.

Gail Nicholson
Analyst, Stephens, Inc.

Q

Good morning. Congratulations on another great Suriname well.

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

Thanks, Gail, and good morning to you.

Gail Nicholson
Analyst, Stephens, Inc.

Q

When you guys look at Egypt activity in the second half of the year, could you just talk about any exploration targets that you guys are looking forward to tackling?

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

I mean, Gail, we continue to work Egypt hard. We've shot a big, very large 3D there. We continue to high grade our inventory. We do have some interesting things that are on the schedule that we're anxious to drill, some stratigraphic targets. And at some point, if they work like we think they could work, then there'll be some things to talk about.

Gail Nicholson
Analyst, Stephens, Inc.

Q

Great. And then, Steve, in the first quarter call, you talked about cash flow sensitivities, or for every $1 move in oil was roughly in the $50 million to $60 million range. Is that still a good proxy to use? Or has that improved?

Stephen J. Riney
Chief Financial Officer & Executive Vice President, Apache Corp.

A

No. That's still a pretty good proxy to use, for every $1 probably close to the $60 million.

Gail Nicholson
Analyst, Stephens, Inc.

Q

Great. Thank you.

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

Thank you, Gail.

Operator: Our next question comes from Arun Jayaram with JPMorgan Chase.

Arun Jayaram
Analyst, JPMorgan Securities LLC

Q

Yeah, good morning. John, I was wondering if you could maybe as a follow up to John's question just give us some thoughts on your plans to delineate the three discoveries you've announced thus far. And thoughts on potentially bringing in additional drilling rig to the theater, call it next year or beyond.

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

Yeah, Arun, I'll just say we have a kind of a procedure through the concessions that we follow. And we have submitted the appraisal plan for Maka. We are working on the appraisal plan for Sapakara. There will be one that follows Kwaskwasi, and clearly there's going be an appraisal program that starts in early 2021. And at this point, that's all I'm at liberty to really say. But we look forward to getting after it.

Arun Jayaram
Analyst, JPMorgan Securities LLC

Q

Great. Great. And just a follow-up regarding Egypt, you guys have talked about the new licensing areas. I was wondering if you guys have processed seismic on your legacy position as well. And perhaps a little bit more detail on when you plan to test the stratigraphic trap play concept that I think you've identified in the Ptah and Berenice discoveries back in 2014.

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

Yeah, I mean, really it's Ptah and Berenice that really kicked off this whole effort. Prior to drilling those wells, we'd shot new 3D in 2013. They were on our legacy acreage position Khalda Offset. It really opened our eyes to the fact that we needed to start looking stratigraphically, not just structurally in Egypt. We had found some things that were stratigraphic in nature through some of the wells that we had drilled in the past. But it really had us design the 3D, which we've been shooting. And obviously we picked up new acreage and are shooting that over a lot of our old legacy as well.

So a lot of prospectivity. We got some wells that we're pretty excited to drill. And the nice thing about those is they're vertical, they're onshore, and they're near the other wells we're drilling, so we can do them pretty quickly.

It's just a matter of working through all the details and prioritizing. The rig count there we've also reduced. We're currently at five. We'd like to spend more there if we could, so.

Arun Jayaram
Analyst, JPMorgan Securities LLC

Q

Great. Thanks a lot.

Operator: Our next question comes from Scott Hanold with RBC Capital Markets.

Scott Hanold
Analyst, RBC Capital Markets LLC

Q

Yeah, thanks. On Suriname, great discovery and congratulations, by the way. Does that discovery really say anything about the positioning or your read of the seismic that you have over some of the other fairways like the Maka, for example? I.e., is there the chance that you guys now see the opportunity for thicker structures other places? Is there anything unique that you've found with that well?

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

Yeah I mean, Scott, good question. I mean, I think what you're learning, too, and is what we're learning, we've still got work to do. We'll continue to reprocess seismic. There are some carbonates and some things that make it harder. We're fairly deep here, as you saw with the TD that we announced in this well. So we're going to continue to work that. I think what it really points out is just the vast size as you move from these first three wells between them and the size of the block.

So we're going get smarter with the reprocessing to better understand everything and put it all together. But the good news is we've got a massive hydrocarbon system. It's working. It's oil. And we've good reservoir in the Santonian and in the Campanian. So we'll learn more as we go and as we really start to drill wells. We've just drilled three. So we'll learn more as we go.

Scott Hanold
Analyst, RBC Capital Markets LLC

Q

And effectively as far as Keskesi goes in terms of where that was positioned, is there any chance that shifts a little bit as you continue to get closer to that area? Is that location pretty well set at this point?

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

No. I mean, as we stated, we had I think nine wells permitted. We know we would drill three for sure. Likely the fourth was the option we exercised. So there, we've got five other locations out there that were picked. Could be appraisal, could be other, so any other exploration targets. But we're sticking with where the original wells were on most of these. I mean, it's Sapakara. We moved over one. So as you go and you learn more, you set yourself up to try to get smarter, but it's going take some more work with the seismic to really change some of the interpretation that we did on the front end.

Scott Hanold
Analyst, RBC Capital Markets LLC

Q

Understood. Appreciate it. Thank you.

Operator: Our next question comes from Brian Singer with Goldman Sachs.

Brian Singer
Analyst, Goldman Sachs & Co. LLC

Q

Thank you, and good morning.

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

Good morning, Brian.

Brian Singer
Analyst, Goldman Sachs & Co. LLC

Q

Sticking with Suriname, how many combined appraisal wells at the three discoveries do you think are needed between moving forward with the codified development plan? And when you think about the appraisal plus the time to get to FID and any government approvals, what's a realistic timing for when we can see early production start-up, and a realistic timing if we see more normal production start-up?

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

Well, I mean, I'd say that number one, we'll determine the number of appraisal wells that we need through the program. And we're working on that. So I really don't have anything to say other than there's going to be a program. And obviously, we've got three discoveries to appraise and there will be contingency wells as we work through those appraisal programs that you'll have with those. Timeline, we said normal process. You're probably in the four to five range in terms of years.

Obviously, there are ways that that could be accelerated, but not ready to comment on anything at this point in terms of putting anything out there. I mean, it's all fresh. We've got the log. We're working through this with our partner. We're working on right now the Sapakara appraisal plan and then we're going get after the Kwaskwasi appraisal plan following that pretty quickly, so.

Brian Singer
Analyst, Goldman Sachs & Co. LLC

Q

Great. And then my follow up is with regards to gas condensate. As you get more data on the gas condensate potential, how are you and your partner considering the potential if at all for gas condensate development and economics? And is there any scale benefits from discovery that you've made as well as in the Stabroek block of Guyana for a larger industry partnership?

David A. Pursell
Executive Vice President, Development, Apache Corp.

A

Yeah, Brian, this is Dave Pursell. I think it's premature to go down any details on that. But the way I think you could think about it is the oil's going to drive the initial development here. And then, gas or gas condensate development is beyond that, kind of a Phase 2 if you will. And obviously there would be some scale benefit in the basin if that were an option. But there's a long fairway between here and that determination.

Brian Singer
Analyst, Goldman Sachs & Co. LLC

Q

Makes sense. Thank you.

Operator: Our next question comes from Richard Tullis with Capital One Securities.

Richard Tullis
Analyst, Capital One Securities, Inc.

Q

Hey thanks. Good morning and, John, congratulations on the big discovery. Two quick questions. With no plans to resume domestic activity until oil prices are considerably higher, what are your current views on potentially monetizing any of the US assets at this point?

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

I mean I'd just say with the portfolio, we're always working the portfolio. We're always looking at how we improve. When we look at our acreage positions out in the Permian specifically, the good news is we don't have a lot of wells. We have to drill to hold acreage. In fact, most everything's HPP. We've been looking at working swaps and things to improve our lateral feet in terms of drillable lateral feet. But I mean it's we're always watching and looking and evaluating the portfolio. I'll just say what we typically do is come back and talk to the market after we've done things rather than setting out expectations or anything on the front end.

Richard Tullis
Analyst, Capital One Securities, Inc.

Q

All right. Thank you. And then just lastly, I know we've been provided a good bit of information on the thickness of the three discoveries. Any initial thoughts on the aerial extent of any of the three discoveries at this point?

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

Thoughts are, I mean, they're very sizable but we haven't given any color. We haven't started to put any acreage size on any of these at this point. And I think it's premature. That's something we'd come back with after we've done the appraisal programs.

Richard Tullis
Analyst, Capital One Securities, Inc.

Q

Okay. Well, that's all for me. Thank you.

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

Thank you.

Operator: Our next question comes from Neal Dingmann with SunTrust.

Neal Dingmann
Analyst, SunTrust Robinson Humphrey, Inc.

Q

Morning all. John or Stephen, my question is just wondering, would the pace of next year's appraisal plan at Suriname, would that have any impact on your decisions on domestic or international play spending?

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

Neal, the way we've structured our joint venture, we've kind of got everything worked in and planned around. I mean, that was the main reason we held on to 100% of this block and really farmed down 50%, because we were really setting ourselves up for success because we believed there was a tremendous amount of potential and thought very likely we would find ourselves in this position. And so that's how we structured it.

So it's really not going to create an incremental capital call that we can't fund it really at any price. Now you get into second quarter where we got all bets are off. But really in a even sub-$30 world, we will be focused on paying down debt and funding Suriname.

Neal Dingmann
Analyst, SunTrust Robinson Humphrey, Inc.

Q

Got it. And then just lastly, my last question just on Egypt. I'm just wondering, you mentioned that you'd probably stay the course if pricing stayed around here it is or, just kind of wondered if you could talk about any price sensitivity, what would cause you to change that.

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

No, Egypt works really well. I mean, and quite frankly, the driver there is how much free cash flow do we think we can spend and invest there. I would like to spend more because we've got a lot of prospectivity there and it works quite well. So we'll be looking to try to spend more money in Egypt if we possibly can.

Operator: Thank you. Our next question comes from Leo Mariani with KeyBanc.

Leo Mariani
Analyst, KeyBanc Capital Markets, Inc.

Q

Yeah, hey. Thanks guys here. Just wanted to kind of get a little bit more color around some of the comments you made with respect to CapEx. I think you guys specifically said that at $50, you'd spend at or below the $1 billion as we work our way into next year. And just wanted to get a sense, I mean, it seems to me that at that level of capital, you're going to see steady production declines in all three of your areas, sort of Egypt, North Sea and Permian. Just wanted to kind of confirm that with you guys.

And then if that is the case, then are you guys just feeling comfortable with that just because of the great initial success in Suriname, where you just think that the long-term economics in Suriname are going to be so good, you're finally letting things blow down for a handful of years until this kind of kicks in?

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

No, Leo, I mean I think the point is we're managing the company for free cash flow and long-term returns. And it's not about production growth. I mean, obviously we're not spending at a level today that would be maintaining production. We do know from past history that as you go forward with us, with our decline rates, some of these conventional assets really start to arrest that decline, so it would take more in the future. But it's a matter of

priorities of how we're managing the company. And I think some of these other assets, some of the things you talked about, they're going to hold up pretty well with under-investment.

Leo Mariani
Analyst, KeyBanc Capital Markets, Inc. Q

Okay. I think it's just with respect to your third quarter production guidance here. You guys have the kind of adjusted international production of 135,000 BOE per day and kind of the upstream CapEx of $190 million. I want to see if you guys could provide those numbers on a kind of fully consolidated basis. So what would those be if we didn't make those kind of downward adjustments for the Egypt non-controlling interest in midstream and other things?

Stephen J. Riney
Chief Financial Officer & Executive Vice President, Apache Corp. A

Yeah, Leo, I don't have those numbers to hand. So I'd suggest maybe you call Gary to take a look at the reported volumes. We typically talk about adjusted because those are the ones that have a true economic effect for Apache shareholders. But I understand the desire to know what the reported numbers might be. So if you want to talk to Gary about that, that'd be probably the best source.

Leo Mariani
Analyst, KeyBanc Capital Markets, Inc. Q

Okay. Thank you.

Operator: Our next question comes from David Deckelbaum with Cowen.

David Adam Deckelbaum
Analyst, Cowen & Co. LLC Q

Morning guys and congrats.

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp. A

Thank you.

David Adam Deckelbaum
Analyst, Cowen & Co. LLC Q

Just curious, you've spoken quite a bit about obviously Suriname. You talked about your capital allocation priorities as commodities improve and the emphasis on free cash. There were reports I guess earlier in the month, or perhaps last month about Apache's potential interest in some other North Sea assets. If we think about Apache, just as a portfolio company now, should we be expecting you to look at opportunistic acquisitions that would increase your free cash per share scale? Or just given the immense resource that might be in front of you, would that be something that would be off the table right now?

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp. A

No. I would just say that number one, we typically as a rule don't comment on rumors. And as we think about portfolio and changes, we typically talk about them after we've done things, right. So if you look at us today, we've always believed in a portfolio. We've believed in diversity. We think we've got strong international assets. We

maintained those at a time when there was push to try to move to more of a pure-play model. And so we've always maintained the balance. We believe in having an exposure to all the commodities and multiple strong legs to the stool that keeps it strong, so.

David Adam Deckelbaum
Analyst, Cowen & Co. LLC

Q

Appreciate that. And then just the last one for me is, you talk about priorities in accelerating appraisal and potentially development, particularly in Block 58. How do you feel now, or how are you thinking now about exploring in some of the other blocks, namely 53? And if there were some leases that opened up towards the end of the year in more of that southern extension in the basin, would we expect Apache to be present in those?

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

Yeah, I mean, when you look at 58, it's a lot to say grace over for us. We're obviously – it was important to us to structure our joint venture where we could maintain 50% of the profit oil. We're thrilled to have Block 53. I think directionally, the way things are moving, it bodes well for 53. So at this point we've got quite a bit to say grace over in that part of the world, but.

David Adam Deckelbaum
Analyst, Cowen & Co. LLC

Q

Fair enough. Thank you, guys. Congrats.

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

Thank you.

Operator: Our next question comes from David Heikkinen with Heikkinen Energy.

David Martin Heikkinen
Founder & Chief Executive Officer, Heikkinen Energy Advisors LLC

Q

Good morning, and thank you for taking my question and congratulations on the success in Suriname. Kind of triggered some memories of many DSTs that looked for perm, really poor pressure and then boundaries. With that thickness, can you talk about how many DSTs you're running? What are you thinking about as far as detecting boundaries? And are there any analogies that, in other basins or the Gulf of Mexico that you could point us to to think about what those results will be as they come in?

David A. Pursell
Executive Vice President, Development, Apache Corp.

A

Yeah, Dave. This is Dave Pursell. Good – thanks for the question. Yeah. When I think about a mini DST, probably the most important piece of information, because it is a mini DST, is the composite flow capacity. So again, that aggregate kind of near wellbore perm across a thicker interval. The deeper reservoir investigation is an added benefit. But you're still not getting out as far as you would in a true conventional drill stem test.

So what this is going to allow – and the number of tests we're going to perform is dependent on a lot of factors, on thickness and a number of things. But what the results are really going to allow us to do is be able to be more

thoughtful in the appraisal program as we come in and design more traditional drill stem tests. And so it's a really good piece of information that's going to, again, make us smarter during appraisal.

David Martin Heikkinen
Founder & Chief Executive Officer, Heikkinen Energy Advisors LLC

Q

Yeah, so really near well bore probably won't get enough distance to see any boundaries and that's really setting up for your future DSTs, not anything more than that [indiscernible] (58:54)

David A. Pursell
Executive Vice President, Development, Apache Corp.

A

Yeah, that's probably the – that's the way to characterize it.

David Martin Heikkinen
Founder & Chief Executive Officer, Heikkinen Energy Advisors LLC

Q

That's helpful. Perfect. Thank you.

Operator: Our next question comes from Paul Cheng with Scotiabank.

Paul Y. Cheng
Analyst, Scotia Capital (USA), Inc.

Q

Thank you. Good morning. Two quick questions. One, in Suriname the discovery seems to be closing up. You should be able to do extended horizontal well and tie it back into one production part. Is that what you intend to do or that the [indiscernible] (59:24) anyway that use maybe two of the FPSO to [ph] give offset (59:32)?

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

Yeah, Paul, it's just early. I mean clearly, the benefit I have on these fairways and things is you're going to have all sorts of options. The key is having resource oil and – as you work through that, and that's some of the stuff that will go into the planning of how we appraise and ultimately make those decisions. But there's a lot of optionality to how you do it.

Paul Y. Cheng
Analyst, Scotia Capital (USA), Inc.

Q

Okay. And last question that you sort of answered it before, but let me try another way to ask. In the Permian, given the success in Suriname, you will be extremely busy in the second half of this decade and probably have very good growth. And so when we're looking at something like in your Permian asset, do you consider it still a long-term core portfolio? Or that is not really considered as a long term core portfolio from what you can see today?

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

No. I mean, we like our assets in the Permian. I think we've always believed it was a key pillar. I think in this price environment today, we've just got places that are going to get capital before that's going to get it. And I'll leave it at that.

Paul Y. Cheng
Analyst, Scotia Capital (USA), Inc.

Q

Got you. Thank you.

Operator: Our next question comes from Jeffrey Campbell with Tuohy Brothers.

Jeffrey L. Campbell
Analyst, Tuohy Brothers Investment Research, Inc.

Q

Good morning and congratulations. I'll jump in on the Suriname success. So, congratulations. Real quick question there. I just wanted to confirm who will operate the upcoming fourth exploration well.

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

Apache will operate the Keskesi well. After that well is when we've already started transitioning with our partner Total. And yeah, I will say we chose the right partner for a lot of reasons, and we're excited to continue working with them and let them take the reins as operator.

Jeffrey L. Campbell
Analyst, Tuohy Brothers Investment Research, Inc.

Q

Right. Well, being a little superstitious, wouldn't mind seeing you guys drill one more well. So glad to hear that. The other quick question was just how many Permian DUCs do you actually have right now in the queue?

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

A

Permian DUCs? We've got, what?

David A. Pursell
Executive Vice President, Development, Apache Corp.

A

Yeah, it's about 50 outside of Alpine High.

Jeffrey L. Campbell
Analyst, Tuohy Brothers Investment Research, Inc.

Q

Okay. Great. Thank you.

Operator: And I'm not showing any further questions. At this time, I'd like to turn the call back over to John for any closing remarks.

John J. Christmann IV
President, Chief Executive Officer & Director, Apache Corp.

Thank you, operator. And thank you to everyone that has dialed in today. To close the call, I'd like to leave you with three key takeaways. First, Apache has responded quickly and aggressively to the volatile price environment thus far in 2020. We are exceeding our cost in capital reduction goals, and we'll continue to relentlessly work these initiatives.

Second, we are laser focused on free cash flow generation, debt reduction and investing for long term returns, not production growth. And lastly, we have a differentiated portfolio that offers attractive investment options in this volatile oil price environment. The long-term future of that portfolio is underpinned by Suriname, where our success rate thus far indicates a very large, high quality oil resource.

We look forward to sharing our progress as we continue to appraise our discoveries and explore for additional oil. And with that, we will conclude the call.

Operator: Ladies and gentlemen, this does conclude today's presentation. You may now disconnect, and have a wonderful day.

Exhibit 43

06-May-2021

APA Corp. (APA)

Q1 2021 Earnings Call

CORPORATE PARTICIPANTS

Gary T. Clark
Vice President-Investor Relations, APA Corp.

John J. Christmann
President, Chief Executive Officer & Director, APA Corp.

Stephen J. Riney
Chief Financial Officer & Executive Vice President, APA Corp.

David A. Pursell
Executive Vice President-Development, APA Corp.

David Clay Bretches
Executive Vice President-Operations, APA Corp.

OTHER PARTICIPANTS

John Freeman
Analyst, Raymond James & Associates, Inc.

Doug Leggate
Analyst, BofA Securities, Inc.

Michael Stephen Scialla
Analyst, Stifel, Nicolaus & Co., Inc.

Jeanine Wai
Analyst, Barclays Capital, Inc.

Charles Meade
Analyst, Johnson Rice & Co. LLC

Gail Nicholson
Analyst, Stephens, Inc.

Paul Y. Cheng
Analyst, Scotiabank GBM

Leo Mariani
Analyst, KeyBanc Capital Markets, Inc.

Neal Dingmann
Analyst, Truist Securities, Inc.

MANAGEMENT DISCUSSION SECTION

Operator: Good day, and thank you for standing by and welcome to the APA First Quarter 2021 Earnings Announcement Webcast Conference Call. At this time, all participants are in a listen-only mode. After the speaker presentation, there will be a question-and-answer session. [Operator Instructions] Please be advised that today's conference is being recorded. [Operator Instructions]

I would now like to hand the conference over to Mr. Gary Clark, Vice President for Investor Relations. Sir, please go ahead.

Gary T. Clark

Vice President-Investor Relations, APA Corp.

Good morning and thank you for joining us on APA Corporation's first quarter 2021 financial and operational results conference call. We will begin the call with an overview by CEO and President, John Christmann. Steve Riney, Executive Vice President and CFO, will then provide further color on our results and 2021 outlook. Clay Bretches, Executive Vice President of Operations; and Dave Pursell, Executive Vice President of Development, will also be available on the call to answer questions. Our prepared remarks will be approximately 15 minutes in length with the remainder of the hour allotted for Q&A.

In conjunction with yesterday's press release, I hope you have had the opportunity to review our first quarter financial and operational supplement, which can be found on our Investor Relations website at investor.apacorp.com.

Please note that we may discuss certain non-GAAP financial measures. A reconciliation of the differences between these non-GAAP financial measures and the most directly comparable GAAP financial measures can be found in the supplemental information provided on our website.

This quarter, we have also introduced the term free cash flow, which is defined on page 20 in the glossary of our supplement. Consistent with previous reporting practices, adjusted production numbers cited in today's call are adjusted to exclude non-controlling interest in Egypt and Egypt tax barrels.

Finally, I'd like to remind everyone that today's discussions will contain forward-looking estimates and assumptions based on our current views and reasonable expectations. However, a number of factors could cause actual results to differ materially from what we discuss today. A full disclaimer is located with the supplemental information on our website.

And with that, I'll turn the call over to John.

John J. Christmann

President, Chief Executive Officer & Director, APA Corp.

Good morning and thank you for joining us today. In my prepared remarks, I will review APA Corporation's first quarter results and discuss our 2021 priorities. Despite some significant weather-related challenges, we delivered a strong first quarter. Specifically, our free cash flow generation was over $500 million. We performed well relative to our production and cost expectations, and our safety performance was excellent.

Our total adjusted production exceeded guidance as Permian oil and gas volumes benefited from a faster-than-expected recovery from the February storm impacts. This more than offset lower international adjusted volumes resulting from the impact of higher oil prices on our Egypt PSC cost recovery barrels and some extended operational downtime in the North Sea. Upstream capital investment and LOE were considerably below guidance for the quarter.

Together with strong price realizations, these factors contributed to an exceptional quarter of free cash flow generation, all of which is being designated for debt reduction. Looking ahead, the full year guidance we provided in February is unchanged, and we are clearly off to a good start.

Turning now to operations in the United States, we reactivated a rig in the Permian Basin, which was previously on standby, and picked up one additional rig to drill a four-well program in the Austin Chalk play of Texas in Brazos and Washington counties. We placed 22 wells online in the Permian, including two at Alpine High. Roughly 5,000 BOEs per day of lower-margin Permian production remains shut in at the end of the first quarter. We are very pleased with the early results and combined with the recovery from winter storm Uri are expecting a significant increase in second and third quarter production.

On Tuesday, we announced an agreement in principle with the Ministry of Petroleum and the Egyptian General Petroleum Company to modernize the terms of our current production sharing contracts, which is the result of a process that has been underway for more than one year. The agreement is comprehensive and when ratified by parliament will result in increased activity, capital investment and oil-focused production growth over the next several years.

Currently, we are running a five-rig program in Egypt and continue to build quality inventory across our expanded acreage footprint. In the first quarter, we had another significant oil discovery at our Hadid prospect, the details of which are in our financial and operational supplement. We are projecting Egypt gross production will bottom in the second quarter and trend up in the second half of the year.

Debottlenecking of certain pipelines of facilities and the addition of compression capacity will enable us to connect roughly 35 wells in the second half of the year compared to only 20 wells during the first half. These and other 2021 guidance items do not include any potential changes associated with the pending PSC modernization, which we look forward to updating after the agreement is formally approved.

In the North Sea, we have been operating one floating rig and one platform rig crew for just over a year. At this pace, we are capable of delivering annual production in the range of 55,000 to 60,000 BOE per day for the next several years. In 2021, we anticipate North Sea volumes will be a bit lower as we experienced unplanned compressor downtime in the Forties Field during the first quarter and will incur extended pipeline downtime and platform maintenance turnarounds during the second and third quarters.

Following this, however, we expect a sharp rebound in production during the fourth quarter 2021. In January, we announced a discovery at our fourth exploration well in Suriname. An appraisal plan for this well, Keskesi, is forthcoming. Total has now fully assumed operatorship of Block 58 and is running two rigs in the vicinity of the Sapakara discovery. Both rigs are capable of appraisal and exploration drilling, which provides ultimate flexibility as we execute our programs. We look forward to providing updates as appropriate in the future.

Next, I would like to review our priorities for 2021, which we outlined previously on our February conference call. First, we are budgeting conservatively and focusing on free cash flow generation and debt reduction. This year,

our reinvestment rate is currently tracking below 50%. Second, we are aggressively managing our cost structure, and we'll continue to do so regardless of the oil price environment.

Third, we are preserving optionality within our portfolio, which will enable us to either develop or possibly monetize certain assets at the appropriate time. Fourth, we are advancing the exploration and appraisal programs in Suriname and are now beginning to benefit from our joint venture [indiscernible] (00:08:28) agreement, which is a very efficient funding source for our differential long-term opportunity in Block 58.

Fifth, we are continuing to focus on value creation through organic exploration. We recently announced the hiring of Tracey Henderson to lead our exploration team, which concludes an extensive search that began prior to the COVID-19 pandemic. Tracey's experience and expertise are a great fit for the existing APA portfolio, and we look forward to her leadership on future exploration strategy and ventures.

And lastly, we are advancing ESG initiatives that are relevant, impactful and core to our business. Broadly defined, these fall into three areas of emphasis: air, water, and communities and people. In 2021, we have established goals that address routine flaring, freshwater consumption, and diversity and inclusion programs. These goals are linked to the annual incentive compensation of not just management but all employees. We made excellent progress in each of these areas during the first quarter, and I look forward to discussing them further as we progress these efforts through the year.

In closing, I would like to thank all of our employees across the globe for their hard work in the first quarter and in particular, our field personnel and contractors on the front lines that did an excellent job of safely navigating global pandemic protocols as well as some very extreme weather events. During the historic freeze in Texas, our teams worked around the clock to maintain and restore the hydrocarbon production systems that are vitally important to ensuring the safety and well-being of people and communities during events such as this.

And with that, I will turn the call over to Steve Riney, who will provide additional details on the first quarter and our 2021 outlook.

Stephen J. Riney

Chief Financial Officer & Executive Vice President, APA Corp.

Thanks, John. As noted in our news release issued yesterday, under generally accepted accounting principles, APA Corporation reported first quarter 2021 consolidated net income of $388 million or $1.02 per diluted common share. These results include items that are outside of core earnings, the most significant of which is a $43 million valuation allowance adjustment for deferred taxes in the quarter. Excluding this and other smaller items, the adjusted net income was $346 million or $0.91 per share.

We had a very good first quarter with most financial results being in line or better than our previous guidance. Notable exceptions were North Sea production, which John addressed, and G&A expense, which was $83 million. While underlying spend was in line with our guidance of around $75 million, additional charges were recognized for the mark-to-market impact on certain stock compensation programs.

First quarter results were significantly influenced by US natural gas pricing volatility associated with Winter Storm Uri. The impacts of the storm appear in several places on the income statement. So let me take you through most of the significant items. Since it determines the reporting of results, I'll first remind everyone of how we handle Permian Basin gas production.

We sell all of our gas production in basin and then manage our long-haul transport obligations separately. We optimize those obligations through the purchase, transport and sale of gas from various receipt points in the Permian Basin and in the Gulf Coast areas. Our common practice, as we contract for the purchase and sale of gas, is to maintain a relatively balanced exposure between gas daily and first-of-month pricing.

As the end of January approached, we had portfolio of purchase and sales contracts that were heavily skewed to February first-of-month pricing. As we commonly do when this is the case, we use financial contracts to rebalance that exposure closer to 50-50. So given the unusually high gas price spike that occurred in mid-February, this impacted first quarter reporting of results in three ways.

First, our underlying sales contracts for produced gas determine the reporting of revenue and realizations. Since approximately half of our underlying sales contracts for February production were at gas daily pricing, you will see a significant increase in both natural gas revenues on the income statement and in the average realized price for US gas for the quarter.

Second, our underlying contracts also determine the reporting of revenues and costs associated with our activities to purchase, transport and sell gas to fulfill our transportation obligations. The results of these activities appear in the lines entitled purchased oil and gas sales and purchased oil and gas costs on our P&L. Combined, we incurred a loss of $54 million on that activity in the first quarter, which includes the cost of the transport and the fuel associated with that transport.

In a normal quarter, given current differentials, we would expect this loss to be in the $25 million to $35 million range. For the first quarter, this loss was compounded by a volume imbalance in our underlying purchase and sale contracts, which resulted in more gas purchased at the higher February daily prices and more sales at the lower first-of-month pricing.

Finally, since we used a financial swap to rebalance our underlying contract portfolio, a good portion of the price spike benefit appears in the $158 million derivative instrument gain on the income statement. If our underlying contract portfolio had been more balanced in the first place, we would not have used the derivative contract and we would not have this gain. Instead, we would have reported higher gas revenues and a lower loss on sales of purchased gas.

I know I went through that quickly and it can be confusing. If you have further questions, please call Gary's team and they can take you through it in further detail.

Free cash flow was also strong in the first quarter, exceeding $500 million. That cash is being used for debt reduction, initially through the pay-down of our revolver. Excluding the consolidated effects of Altus Midstream, we reduced net debt by $339 million in the quarter, mostly through the retention of cash. If the current price environment holds up, we anticipate at least $1 billion of net debt reduction in 2021.

Turning now to some additional comments around our 2021 outlook, our full-year 2021 production, capital, LOE and G&A guidance all remain unchanged. Assuming the recently announced PSC modernization in Egypt proceeds on course, we anticipate adding some capital activity in Egypt for the second half of 2021. We will update our guidance for Egypt as we proceed through that approval process.

We have also expanded our guidance to include the anticipated effects of purchasing and selling gas in the US to fulfill our transport obligations, which I discussed previously. Lastly, for the remainder of the year, we expect our

US natural gas realizations will closely approximate Waha and El Paso Permian pricing. You will find all of our current guidance items in the financial and operational supplement.

In closing, we look forward to a very strong year of free cash flow generation of at least $1 billion. This should take us a good bit of the way toward our previously-mentioned leverage target of around 1.5 times debt-to-EBITDA under a mid-cycle pricing scenario.

You should understand, however, that our more relevant objective is to return to investment-grade credit status. To that end, we will continue to budget conservatively, focus on costs, free cash flow generation and debt reduction and maintain close contact with the rating agencies to ensure that we are taking the appropriate steps to achieve that goal in a timely manner.

And with that, I will turn the call over to the operator for Q&A.

QUESTION AND ANSWER SECTION

Operator: Thank you. [Operator Instructions] Our first question comes from the line of John Freeman from Raymond James. Sir, your line is open.

John Freeman
Analyst, Raymond James & Associates, Inc.

Q

Good morning, guys.

John J. Christmann
President, Chief Executive Officer & Director, APA Corp.

A

Good morning, John.

John Freeman
Analyst, Raymond James & Associates, Inc.

Q

The first question I had was just on what Steve said there at the end about potentially [indiscernible] (00:18:00) PSC has done in Egypt about adding some additional capital and activity in the second half of 2021 in Egypt. And obviously, that's consistent with what you've said in the past, John, about eventually wanting to get to US and Egypt and 2022 and beyond is sort of more of a maintenance level activity at the least.

And so, I know in the past the sort of the commentary around Egypt had been from the five rigs you're currently running, probably wanting to get to at least a couple of rigs more to at least get to that maintenance level. So until told otherwise by you all, is that a fair assumption to assume that that's kind of where you want to get to on the Egypt for the – by year-end?

John J. Christmann
President, Chief Executive Officer & Director, APA Corp.

A

I'll make a few comments just in general on Egypt and then I'll have Dave step in a little bit in terms of just rig count and things. But I think what you've seen is, finally, we can get out in the public about our real important step in the process that we've been working through and modernizing our PSCs in Egypt. This is something that we started really prior to the COVID-19 pandemic.

But I will tell you, we've been negotiating in good faith and in earnest with Egypt for more than a year. And we're at a point today where after working with the Minister of Petroleum as well as EGPC, we were able to announce this on Tuesday. It's really a framework that sets the future for Egypt. We've been clear not to touch guidance this year. We've now have to go through the approval process, and there are some steps to go through, the parliamentary process and ultimately get things ratified. And then we'll be able to talk more about it.

But as we go through the year, we will be picking up some activity. There's just a lot of projects in Egypt that had been – become noncompetitive because of the terms of the PSC, and this is really going to open up some projects that we're ready to fund. I think this is going to be a win-win for both the country of Egypt and Apache, and it's going to really put us on a much stronger than just maintenance curve for Egypt.

So, Dave, I'll let you jump in and add a little bit more to that.

David A. Pursell
Executive Vice President-Development, APA Corp.

A

Yeah. Thanks. Let's step back. And I think, John, you had – you framed your question on what we've said before around wanting to maintain the business, and so let's think about maintenance capital. So right now, we're going to spend this year roughly – these are going to be round numbers, $900 million of development capital and that's – and in that mode, production's in a modest decline. So we think about two places we'd want to flex capital to arrest that decline that would be in the US in the Permian Basin primarily and in Egypt.

If you think about a rig line, we've talked about needing potentially a full rig line or a partial rig line addition to the two, we'll have in the second half of this year in the Permian to sustain production and then more rigs in Egypt. And we've talked about seven to eight rigs needed to sustain or maintain production there.

And so if you think about a rig line in the Permian and a handful of rigs in Egypt, that puts you roughly $200 million incremental. So our maintenance capital is about $1.1 billion. And the key here is we're not talking about material growth, what we're talking about maintaining production. And that gives us some optionality in the portfolio to where we want to add that capital to maintain our global production. And so that frames the maintenance capital, and I'll throw it over to Steve to add some more color around that.

Stephen J. Riney
Chief Financial Officer & Executive Vice President, APA Corp.

A

Yeah. So we entered – I think a good context for this is that we entered the year – as people will recall, it seems like years ago, but we entered this year with a plan that was based on $45 WTI, and it had a – as Dave called it, the development capital, the $900 million of development capital we just set aside for Suriname was about a 60% reinvestment rate. And at current strip, that same amount of capital is less than a 40% reinvestment rate.

So clearly, this is not a reinvestment rate that's going to sustain – it's not a maintenance level of capital spending. And so we've got a continued slight decline in production volumes. And we've talked about this in the past that the number one priority coming into the year when it still looked like a pretty difficult year was that we needed to get debt paid down. We needed to get the balance sheet strengthened and we needed to start that process, and that was the most important financial priority.

But it is prudent to spend at a maintenance capital level and to maintain the production volume going forward, and we probably need some more in the neighborhood of $100 million to $200 million more development capital in order to get into that neighborhood. And with prices where they are and if they hold up, I think we're likely to start

increasing capital in the second half in order to get to that point. And most of that, as Dave outlined, is going to be in the Permian and Egypt, especially Egypt with the modernization efforts as that proceeds and gets the final approval.

And I just want to echo on that. The issue there was the old structure of the PSCs and how they work. These were very old vintage PSC structures. And it has nothing to do with the fact that that Egypt actually has some very highly economic opportunities and quite a bit of them and just needed the PSC structure that enable the capital investment in that.

And I'll just echo once again John's point that none of this is in our guidance. It's not in the capital for guidance nor is it in the production volume or anything else for guidance. And just to reinforce what Dave said, I'd ask that you please don't throw us into the bucket of growthers because this is not is not an aggressive growth spending plan. This is just about a prudent step towards getting to at least a maintenance level of capital spending.

John Freeman
Analyst, Raymond James & Associates, Inc.

Q

I appreciate that. That makes a lot of sense. Just the follow-up, related – sort of tied to that is I see what sort of the activity has been in Suriname to the first half of the year where Total made the decision to focus more on appraisal here in the first half of the year as opposed to immediately taking that second rig up to Bonboni for the exploration program. And I guess we'll just wait to see when we ultimately get up to Bonboni.

But at the very least, it seems like just given that you all are on the hook for 12.5% on appraisal versus 50% on exploration, it seems like that created a little bit of slack in the budget, unless I'm reading too much into it. There's at least a little slack because just by definition, it seems like [indiscernible] (00:25:37) start of the year is probably a touch lower just given the – a little bit more of a skew toward appraisal versus exploration at least through the first half of the year.

John J. Christmann
President, Chief Executive Officer & Director, APA Corp.

A

Yeah. And I guess, John, when we you look at the Suriname budget, we really haven't touched that, right? I mean it's just a timing thing. Bonboni will be the next exploration well. We're obviously anxious to go drill it. And it is 45 kilometers to the north. So it's – to give you an idea just the scale and scope. So we aren't shifting dollars there or consuming any of that. We've left the Suriname budget kind of where it is. That's just the kind of timing. And quite frankly, we had a pretty good idea what their cadence was going to be as we entered this year anyways.

John Freeman
Analyst, Raymond James & Associates, Inc.

Q

Great. Appreciate it, guys.

John J. Christmann
President, Chief Executive Officer & Director, APA Corp.

A

Thank you.

Operator: Thank you. Our next question comes from the line of Doug Leggate from Bank of America. Sir, your line is open.

Doug Leggate
Analyst, BofA Securities, Inc.

Q

Thank you. Good morning, everybody. I'm afraid I'm going to pound you on a little bit on Egypt just to round out the – the last John's questions. Steve, I wonder – I know you're going to give us details later on, but I just wonder if I could touch on a couple of aspects of why this could be a big deal for you guys. I think it's 10 years since we closed our primer on this, believe it or not.

The cost pool, the potential for extension and the implications of that seismic shoot you've been doing, particularly over the oil play in the Western Desert, can you offer any – can you quantify perhaps what no ring fencing can do to the cost recovery or the cost that you have outstanding there, and whether you would get an extension on those concessions as part of this agreement?

John J. Christmann
President, Chief Executive Officer & Director, APA Corp.

A

No, I mean – Doug, great question. And you'll have to just wait until we get things finally approved for us to really dive in and give any – a lot of details on it. But I'll just say, we – stepping back, it's a holistic approach. This is something that will be good for Egypt. We've looked at things very carefully. This has been a process that has been very lengthy and very thorough and very comprehensive. And it really is in line with the minister's objective of modernizing the oilfield in Egypt. And I think it's going to have some benefits that's going to enable us to direct more dollars into the drilling programs and into the volumes, which are going to generate more revenue.

And so we've got a deep inventory. We're seeing good early results off of the seismic with the Hadid announcement that we had this – within the supplement this go around. So, we're excited about Egypt. And quite frankly, this really puts us in a position where we can fund some projects that are ready to go.

Doug Leggate
Analyst, BofA Securities, Inc.

Q

Forgive me for getting technical on this, John, but I just want to make sure you understand my question. Do you have isolated cost recovery pools that you couldn't recover because they were ring-fenced? And I'm just trying to understand if you could – your share of production could go up sort of overnight as a consequence of being able to tap into those cost recovery pools growth without any incremental capital.

John J. Christmann
President, Chief Executive Officer & Director, APA Corp.

A

I fully understood your question. I'll just say again, I can't get into a lot of details until we close. But this is going to be a win-win for both us and Egypt, and it's going to let us put more dollars in the ground and raise out investments. Steve, do you want to?

Stephen J. Riney
Chief Financial Officer & Executive Vice President, APA Corp.

A

Yes. I'd just say, Doug, we applaud and respect the effort. We just can't get into details because it's still got quite a bit of process to go. But we've made a major milestone here with the agreement in principle. And so we're on our way.

And I'd just like to reiterate, Egypt is a fantastic country to do business in and it's got some of the best underlying opportunity in our entire portfolio and long legs on that inventory as we're proving with the seismic and some of the activity going on on the exploration side. And all we're accomplishing through this is the – is getting rid of an

old outdated PSC structure that created artificial barriers to being able to access some of that really attractive opportunity. We'll give a lot more details as we get closer to this.

Doug Leggate
Analyst, BofA Securities, Inc.

Q

Okay. I don't want to hold the call guys. That was actually my first question. My second one, I won't go to Suriname at this time, but I'd like to ask you, Steve, about free cash flow. Look, obviously, $500 million of – adjusting for working capital, $1 billion for the year to current strip. There is some something not adding up there. I just wonder if you could just frame for us what you think the scale of the more than $1 billion could look like. And more importantly, in a relatively complex portfolio in some people's view, what's the longevity ex-Suriname of sustaining that free cash flow from the current portfolio? And I'll leave it there. Thanks.

Stephen J. Riney
Chief Financial Officer & Executive Vice President, APA Corp.

A

Yes. Great, Doug. And I think that I was probably a bit too understated in my prepared remarks. And the point of that was really just to highlight where we've gotten to in one quarter from the plan that we laid out to all of you in February. Our original plan, as I said, we [ph] reported (00:31:32) $45 WTI. It had somewhere around $350 million of free cash flow. And the point of my prepared remarks was to – just to indicate that it's over $1 billion now. And maybe I could do a little bit better than that and say that at the current strip, it will be well over $1 billion.

The only thing I would say about that, though, is we don't give guidance on free cash flow. We haven't done that in the past. And I don't want to start that process on an iterative basis at this point, mainly because there are so many different measures out there of what people call free cash flow. And we've defined what ours is. So we're very clear about that. But we're going to continue not to give guidance on it.

And the second thing I would say is if I go back to my comments earlier around maintenance capital, on the – if you just set Suriname aside, we're somewhere – yet, we continue to invest $200 million in Suriname. You only need about – somewhere between $100 million and $200 million more to get to a maintenance level of capital on the development side. So, we're not far from that.

And then – and so that's what your difference is. It requires $100 million to $200 million more in order to sustainably access this, what I would call, well over $1 billion of free cash flow in this price environment for an extended period of time. And I think what we've shared in the past is that we certainly are confident we can do that for 5 to 10 years, and we're always looking for opportunities to be able to do that for an extended period of time beyond that.

Doug Leggate
Analyst, BofA Securities, Inc.

Q

Steve, that's really helpful. I mean Suriname [indiscernible] (00:33:37) and I appreciate the answer.

Stephen J. Riney
Chief Financial Officer & Executive Vice President, APA Corp.

A

Thanks for the question. Gave me the opportunity to be a little less conservative on the free cash flow.

Doug Leggate
Analyst, BofA Securities, Inc.

Q

Appreciate it, guys. Thank you so much.

John J. Christmann
President, Chief Executive Officer & Director, APA Corp.

A

Thank you, Doug.

Operator: Thank you. Our next question comes from the line of Michael Scialla from Stifel. Sir, your line is open.

Michael Stephen Scialla
Analyst, Stifel, Nicolaus & Co., Inc.

Q

Thanks. Good morning, everybody. John, you mentioned in your prepared remarks about potential non-core sales. I just wanted to see if you could talk about that anymore, maybe what assets might be included there and how far along in the process. Or is there a formal data room planned for that? Or where are you in that process?

John J. Christmann
President, Chief Executive Officer & Director, APA Corp.

A

Mike, thanks for the question. We typically wait to talk about portfolio transactions and things after we've announced them and so forth, but I don't think it's a big secret. We've had a pretty small package in the Permian that's in the market. It's non-core, some higher cost waterflood type stuff that we may be in a position to transact on. We'll see. We're kind of working through that now.

I think the point is we've got the rig running in the Chalk. We're open to looking at what we will and will not be investing in. And as we make progress on things like modernization in Egypt, it's a continual process for us. So, a lot of key things going on, but we're open and always looking at various things with the portfolio.

Michael Stephen Scialla
Analyst, Stifel, Nicolaus & Co., Inc.

Q

Okay. Thanks. And I wanted to ask on Suriname, just kind of a follow-up on the deeper test at Keskesi. You ran into the pressure issues before you could test the Neocomian. I think you said in your release, it nevertheless helped validate your geologic model. I just want to see if you could add any color on that and what you saw in that process.

John J. Christmann
President, Chief Executive Officer & Director, APA Corp.

A

Well, with Keskesi, there were a couple of things that happened there that I think were key. Number one, we got down below the unconformity. I think, number – and proved that we had charge in hydrocarbons. I mean that's obviously why we had to stop.

And then, the other key fact that was important was at that depth, we proved that we could have quality reservoir in those carbonates. And so – and it also was very, very rich hydrocarbon, not just a dry gas. So, we're encouraged by that. It's a prospect and a play that's going to need to be tested, but it's also going to take a different well design than what we had.

We were very close to getting down to the first target. There were two targets that we're going after. But we had to call it early and we did, but that's something we'll be working with our partner, Total, on to come back with an exploration well that will test those Neocomian targets at a later date, because both of us were encouraged by what we had seen leading up to getting very close to the first target.

Michael Stephen Scialla
Analyst, Stifel, Nicolaus & Co., Inc.

Q

Great. Thanks, John.

Operator: Thank you. Our next question comes from the line of Jeanine Wai from Barclays. Ma'am, your line is open.

Jeanine Wai
Analyst, Barclays Capital, Inc.

Q

Hi. Good morning, everyone. Thanks for taking our questions.

John J. Christmann
President, Chief Executive Officer & Director, APA Corp.

A

Good morning, Jeanine.

Jeanine Wai
Analyst, Barclays Capital, Inc.

Q

Good morning. Thanks for the time. Maybe just two quick ones on the balance sheet. Can you talk about the medium-term plan for adjusting the balance sheet? You've got a ton of free cash flow on the horizon. So, there's a lot of options here. Do you intend to retire debt as it comes due or are there opportunities to retire or further refinance at lower rates earlier?

Stephen J. Riney
Chief Financial Officer & Executive Vice President, APA Corp.

A

Yeah. Hey, Jeanine. So, this is Steve. Yeah, we've talked about the fact that we are – we've talked externally about – we're targeting at least getting down to a 1.5 times debt-to-EBITDA. We may need to move lower than that. Certainly, the direction things have been moving in general over time. We believe something at or below that number is going to be what's required to get back to investment grade. And as I said in my prepared remarks, that's ultimately the real underlying goal is to get back to investment grade and we're going to do whatever it takes to do that.

We're clearly making some tremendous progress this year. By our estimation at the current strip, we'll have net debt-to-EBITDA down to – approaching to about 2.1 times debt-to-EBITDA at the end of this year. Even if you adjusted that to – well, what would happen if we were in a $55 price environment for 2022, we'd still only be slightly higher than the 2.1 times, maybe 2.2 times or 2.3 times. So it doesn't move up considerably. So, we've made tremendous progress or will make tremendous progress this year if prices hold up.

As far as how we're going to do that, we haven't gotten into the details of exactly how we're going to do that. But it obviously has to result in paying off some of the bonds historically. And what we've generally said is we're going to do it the same way we've done it in the past and we've done combinations of open market repurchases. We've done 10b5-1s. We've done tender offers, refinances and we will do all of the above.

I don't believe – at this point in time, I don't believe you'll see a material amount of refinances going forward until we get back to investment grade. We've got about a little over $335 million of debt maturing in the next couple years and that will just be paid down as it matures.

Jeanine Wai
Analyst, Barclays Capital, Inc.

Q

And so, maybe following up on – so the ultimate goal is to get back to investment grade. How do you view that versus more meaningfully increasing the dividend? Are those two things kind of mutually exclusive or do you think you can do both of them at the same time?

Stephen J. Riney
Chief Financial Officer & Executive Vice President, APA Corp.

A

Yeah. Obviously, both of those are important. I think we have to get the balance sheet in order and get debt down and get – at least at a minimum, get back closer to a point where we think we can achieve investment grade before we start looking at the dividend again.

And as we've discussed before and I think we've talked with you specifically about it, we look at debt pay-down as a return to shareholders, because every dollar of debt that we can get off the balance sheet today will add more than $1 to the market cap of the company, we believe, because we think that the debt level is actually weighing on the share price. And so while it's not the same as a dividend and we recognize that, it does benefit shareholders directly with debt pay down.

And we haven't made any specific plans as to what we're going to do. We've got quite a bit still to accomplish on the debt pay-down effort. We – as I said, we'll accomplish quite a bit of that, hopefully, this year. We'll need to do more of it in 2022. And at an appropriate time, we'll reconsider whether we need to bring the dividend back or whether we want to start bringing the dividend back, and we'll certainly hold out the option that we could start looking at the dividend prior to actually getting investment grade. That is clearly an option for us.

Jeanine Wai
Analyst, Barclays Capital, Inc.

Q

Great. Thank you for all the detail. Appreciate it.

Operator: Thank you. Our next question comes from the line of Charles Meade from Johnson Rice. Sir, your line is open.

Charles Meade
Analyst, Johnson Rice & Co. LLC

Q

Good morning, John, to you and the rest of your team there.

John J. Christmann
President, Chief Executive Officer & Director, APA Corp.

A

Good morning, Charles.

Charles Meade
Analyst, Johnson Rice & Co. LLC

Q

I wondered if I could go back to Egypt and just ask a question where I think I know the answer. But in principle – I recognize you can't talk about the details yet. But in principle, are we talking about that there's some opportunities that are obvious to you and obvious to Egypt but it's also obvious to Egypt that you're not pursuing them because of the – maybe some oil price thresholds that are quite low in those PSCs? And so that's the win for them, do I have the right framework?

John J. Christmann
President, Chief Executive Officer & Director, APA Corp.

A

Yeah. I'll just say that there were some projects that the PSC was making them less competitive, right? And by modernizing the PSCs, there's projects that move up the queue that we can fund. And we'll be looking forward to fund. So there's no doubt it's a critical step.

And this is not – it's not uncommon. You got to understand these PSCs, we've been in Egypt for over 2.5 decades now. A lot of these fields have been operated since the mid-1990s. And so stepping back and going through this, this is just the evolution that's required in an oilfield, right, so.

Charles Meade
Analyst, Johnson Rice & Co. LLC

Q

Yeah. That's right. I imagine if you'd ask the people who had written them if they were going to stand for all time, they would have said absolutely no. But If I can ask the second question about – you mentioned in your prepared remarks and you guys put out a press release about bringing Tracey Henderson on to head up your exploration. So, she has some experience drilling offshore Suriname. And I wonder if you could just talk a little bit about more – a little more about where you see her getting rubber to the road or really helping your process both in the near term and the long term. I know that you're still the operator Block 53, if I'm not mistaken. So that's one obvious place in the near term. But can you talk a little bit about how you expect her to fit in and contribute?

John J. Christmann
President, Chief Executive Officer & Director, APA Corp.

A

Well, I mean, I think it's all about building the executive leadership team that we want for long-term. And Tracey brings a wealth of experience and a wonderful skill set. She's worked in small publicly traded companies, so she understands where they had to explore for a living. I think she'll bring a lot of expertise, a lot of experience. She's built exploration teams. I think we've got a lot of key pieces here that she'll be able to come in and hit the ground running and work with, and a portfolio that fits a lot of her expertise. So, she was absolutely our number one candidate and we're thrilled to have her join us.

Charles Meade
Analyst, Johnson Rice & Co. LLC

Q

Thank you for that color, John.

John J. Christmann
President, Chief Executive Officer & Director, APA Corp.

A

You bet.

Operator: Thank you. Our next question comes from the line of Gail Nicholson from Stephens. Ma'am, your line is open.

Gail Nicholson
Analyst, Stephens, Inc.

Q

Good morning. LOE came in sadly below guide for 1Q. Can you talk about the drivers here and the ability to replicate any of those 1Q savings going forward?

David Clay Bretches
Executive Vice President-Operations, APA Corp.

A

Yeah, Gail. This is Clay Bretches. And with regard to the LOE, it was just a masterful performance by our operations folks in the field. They did a great job. They understood the task that was at hand. Last year, we went through some significant cost-cutting exercises. We identified the areas where we could cut cost. We knew that those needed to be sustainable, especially when we were looking at commodity prices in 2020.

So, we had an all-hands-on-deck approach to this. There was a lot of bottoms-up initiatives that led to this LOE reduction. It wasn't short-term. It wasn't just deferral of expenditures, maintenance, et cetera. There was some of that, but it wasn't significant. The big issues here in LOE reduction had to do with those initiatives that took place.

If you take a look at where we had the most significant reductions, it was in the Permian. A lot of that had to do with the wells that we shut-in. We have a lot of wells that – or what we call frequent flyers, wells that go down a lot. We took those out of service, and those are still shut-in because they cost us a lot of money and they're not economic to run.

Furthermore, a lot of our waterflood properties that just weren't providing the economics, we went through and looked at these on a well-by-well, field-by-field basis. There's a lot of water that's not being injected right now because it's really expensive to inject that water. We still have approximately 300,000 barrels a day of water that we don't inject, which saves us a lot on electricity, a lot on maintenance, a lot on personnel overall.

So, in general, it's just the approach that we took. We want to maintain that. That's something that we talk about as an operations group on a regular basis, how do we maintain this low LOE profile as we go forward. In light of the fact that commodity prices are increasing, we do have concern about inflation in service costs. So we focus on making sure that we keep that LOE down, continue to strive to find initiatives that are going to keep the LOE down and flat in light of the fact that we know that there's going to be some inflationary pressures going forward. So, really, again, just kudos to our operations team for getting us to where we are and maintaining those levels.

Gail Nicholson
Analyst, Stephens, Inc.

Q

Okay. I appreciate the clarity. And then, just moving kind of on the ESG front, in regards to carbon capture, some of your North Sea peers are looking at carbon capture projects. Are you in the process of potentially doing anything in that vein? And/or do you see any potential for carbon capture of projects on your North Sea portfolio?

John J. Christmann
President, Chief Executive Officer & Director, APA Corp.

A

Yeah. Gail, on the ESG front, we've emphasized there's really three areas. I mean we're focused on air, water, communities and people, right? And I think the key for us too is we're focused on near-term projects that we can do that can make an impact.

And I think the area we're focused on right now mainly is flaring. And in the – basically in the US, where we're committed to eliminating our routine flaring by year-end this year as well as delivering less than 1% flaring intensity. So, key goals there. We're looking at things in the North Sea. But as far as right now, the near term things, we're looking at some of the low-hanging fruit that we can get after.

I don't know, Clay, if you want to add anything on carbon side in the North Sea.

David Clay Bretches
Executive Vice President-Operations, APA Corp.

A

No. Just what you said, obviously, there's a price on carbon in the North Sea, which creates opportunities. Anytime you have a price on carbon, that creates some economic incentives to study carbon capture. So, we will take a look at that anywhere that we see a price on carbon. It is something that we were paying attention to in the North Sea. But like John said, what we're focused on right now from an ESG standpoint are those areas that we have control and which are going to be impactful for Apache. So, the really big initiative for us from an ESG standpoint is to end our routine flaring in the US onshore by the end of 2021.

And we think this is really significant. You hear a lot of ESG claims out there that talk about some type of initiative that's aimed at 2030, 2040, 2050. What we're doing is saying we're going to end routine flaring by the end of this year. And we think that's really significant. And it represents a significant commitment by Apache to do the right thing and to produce responsibly. And we've shown that over and over.

If you take a look at the investment that we have made in midstream solutions to make sure that we are performing responsibly, not only with Altus Midstream with those gathering and processing assets that we have in the Delaware Basin but also our significant investment in the Gulf Coast Express Pipeline, Permian Highway Pipeline. Both of those are moving over 4 billion cubic feet of natural gas out of the Permian Basin that not only serves Apache but it serves the basin in general, getting that gas out of there and creating opportunities for others to get gas that otherwise would be flared out of the basin.

So, we've put a lot of investment in those pipes. We've put a lot of commitment in terms of firm transportation to anchor those pipes. So, we feel like we're really doing a lot that impacts the gas flaring and ESG initiatives in real time.

Gail Nicholson
Analyst, Stephens, Inc.

Q

Great. Thank you. Great color. Looking forward to back half of the year.

John J. Christmann
President, Chief Executive Officer & Director, APA Corp.

A

Thanks, Gail.

Operator: Thank you. Our next question comes from the line of Paul Cheng from Scotiabank. Sir, your line is open.

Paul Y. Cheng
Analyst, Scotiabank GBM

Q

Thank you. And good morning, guys.

John J. Christmann
President, Chief Executive Officer & Director, APA Corp.

A

Good morning, Paul.

Paul Y. Cheng
Analyst, Scotiabank GBM

Q

Can I just get some maybe your intention for Egypt and Permian over the next several years? I mean we know that you most likely than not that – probably going to raise the activity level to the sustaining level for those two area. But over the next several years there, are we going to trying to maintain them flat or that you were trying to grow a bit? And is that in any shape or form tied to your debt reduction target? Or that – how's that decision-making or that type process is going to be? That's the first question.

The second question is in Suriname, Total have indicated they will sanction the first development this year, coming on stream in 2025. Any kind of color you can provide that – which discovery is going to be target and whether that you will be doing similar to what Exxon did in [indiscernible] (00:52:42) early production system, trying to learn to diversify and learn the whole operation before you go to the full blown operation. Thank you.

John J. Christmann
President, Chief Executive Officer & Director, APA Corp.

A

Paul, thanks. Two good questions, I would say. First of all, when we look at the portfolio, we've said for 2021 not to touch guidance or anything right now. So, modernization in Egypt is going to have a big impact for us. It is going to enable us to put Egypt back on a track where we can grow those volumes, and I think it's going to be very beneficial.

I think in Permian, we've got one rig running today. We're planning to pick up a second rig midyear. As David said, we need to grab another rig there to kind of maintain our Permian volumes, and that would be an objective of ours. But I think as we look going forward beyond that, we don't see trying to ramp up to a big activity pace and try to grow aggressively that – we think we want a modified, moderate investment pace where we're investing very wisely and very – making very capital efficient use of that capital.

Your question on Suriname, clearly, we're underway with – as Total as operator. They've got two rigs running in the vicinity of the Sapakara discovery. We have not put out any timelines and I don't see anything magical about when you need to FID a project. I think the key for us is, is doing the appraisal work, collecting the data, so we can ultimately FID a project.

There's lots of optionality. You are very likely looking at potential FPSOs like what has been done next door, but it's just really premature to get into anything there. I don't see anything magical about a year-end timeline to make a first oil 2025. I think that could easily slide into next year and still make that type of timeframe.

So, we're not pressing for any hurdle there. You want to do the work, you want to do it right and then you want to be in a position to FID the projects when you're ready to FID the projects.

Paul Y. Cheng
Analyst, Scotiabank GBM

Q

Hey, John. Can I just go back into the first question that you said you're not going to increase the activity [ph] a moment (00:55:17) trying to have a major growth? Is that a function to your debt reduction target because you haven't reached that yet? Or that is just because you think the world doesn't need more oil even though the commodity price is strong?

John J. Christmann
President, Chief Executive Officer & Director, APA Corp.

A

Well, Paul, I think, in the short term, it's a function of needed debt reduction. But I think longer term, it's just in the – it's part of the function of more cash flow for shareholders. And we've been in a position for quite some time that

growth was not an objective that was worth chasing in and of itself and that this business needs to be something that's returning cash to investors.

We need to get the balance sheet fixed first in order to do that. As I mentioned earlier, we think reducing debt is a return to shareholders, just a different type. But longer term, when we get debt where it needs to be, we're not going to be looking for double-digit growth, but we're going to be returning cash to investors.

Paul Y. Cheng
Analyst, Scotiabank GBM

Q

And, Steve, I just want to reaffirm that. I think earlier, you guys said that you're going to add a rig in Egypt. That's not included in the current budget. And same as that for Permian, if you're trying to maintain as a flat production. So, if we're going to do those, then that means that your overall CapEx for this year is going to be higher than $1.1 billion, right?

Stephen J. Riney
Chief Financial Officer & Executive Vice President, APA Corp.

A

Yes. Let us be clear one more time maybe. We are not changing our guidance at this point in time. We just said that if prices hold up and we continue to make progress on the Egypt modernization, we may be looking at some further capital spending or capital activity in the second half of the year. If we were committed to doing that, we would be looking at contracting rigs and we would be telling you we're changing guidance, but we're not doing that right now.

Paul Y. Cheng
Analyst, Scotiabank GBM

Q

Okay. Perfect. Thank you.

Operator: Thank you. Our next question comes from the line of Leo Mariani from KeyBanc. Sir, your line is open.

Leo Mariani
Analyst, KeyBanc Capital Markets, Inc.

Q

Yeah. Hey, guys. Just wanted to follow up a little bit on Egypt here. In terms of the Hadid discovery, can you maybe just give us a little bit more color around that? Is this something that rose out of the new concessions and new seismic that you folks shot? When do you see first production from that potential discovery here? And then, additionally, do you think that this discovery unlocked a bunch of other drilling opportunities for you late this year and into 2022?

John J. Christmann
President, Chief Executive Officer & Director, APA Corp.

A

Yeah. Leo, great question. It is a result of the new seismic. It was 2013 when we shot our last vintage and then we started shooting this new seismic and really the 2018, 2019 still shooting process out there. It's given us more clarity where we can see things that are more subtle and we're starting to move really from just drilling big bumps to things that have a stratigraphic element to them.

This is a trend where it sets up multiple wells within the discovery area, but it also sets up very similar-looking prospects that look much like it. So, it really gives you some insight into the lens we have now and the opportunity

that we know sits out there that we now can start to crystallize as we continue to drill more wells off of the new seismic and refine that process.

So, on timing, I don't have that for you today. I can let – I think Clay can jump in on that on – actually on the Hadid well.

David Clay Bretches
Executive Vice President-Operations, APA Corp.

A

Yeah. So, Leo, this is Clay Bretches. And on the timing for the Hadid, we're laying pipeline right now and we're making sure that we have a pipeline that is sized appropriately for the Hadid, but also for growth opportunities, just like what John said, based on follow-on wells in and around Hadid. And that pipeline is being laid right now and should be in service in the fourth quarter of this year.

Leo Mariani
Analyst, KeyBanc Capital Markets, Inc.

Q

Okay. That's helpful. I just wanted to jump over to the North Sea here. You guys certainly had some unplanned downtime in the first quarter, but you're also saying there's going to be – it sounds like some more of that in the second quarter and then maybe some normal planned turnarounds in the third quarter. Could you give us a little bit color on how you see North Sea volumes progressing? Would you expect second quarter to go down further or would be more flat with first quarter?

And then, just kind of what's the cadence into third quarter? Is it down further? And I think you guys were saying that fourth quarter production should be up a lot. Just wanted to understand the cadence in the next few quarters.

John J. Christmann
President, Chief Executive Officer & Director, APA Corp.

A

Yeah. I mean it's all planned activity. Second and third quarter were from the get-go plan, it's pretty heavy maintenance periods. We were unable to do some of it last year. So they're going to be a little heavier this year. And then, you're going to have a really strong rebound in Q4 as we bring everything back online. So, I think our guidance for the year is we reiterated that.

And I don't know, Dave, is there anything else on shape or anything for Qs two and three for North Sea?

David A. Pursell
Executive Vice President-Development, APA Corp.

A

Yeah. Just to reiterate what John said, the tars in the second, third quarter are probably a little larger than normal because they were abbreviated last year because of COVID issues. So, we'll see a second and third quarter impacts, rough order of magnitude, those are kind of in the 6,500 BOE per day range expected through the quarter for second and third quarter just on those impacts, and we'll see a rebound in the fourth quarter. So again, as John said, no change to guidance.

Leo Mariani
Analyst, KeyBanc Capital Markets, Inc.

Q

Okay. Thank you.

Operator: Thank you. Our last question comes from the line of Neal Dingmann from Truist Securities. Sir, your line is open.

Neal Dingmann
Analyst, Truist Securities, Inc.

Q

Thanks for squeezing me in, guys. Just my last question, I don't know if there's anything about this, but I'm just wondering. We've seen a nice run continue not only in oil, but in gas. Any thoughts on potential incremental activity in the Alpine this year or early next?

David A. Pursell
Executive Vice President-Development, APA Corp.

A

Yeah. Neil, this is Dave Pursell. From an activity standpoint, we have five DUCs that we're completing as we speak. We completed two earlier in the year. We're going to evaluate the performance of those. But given where oil prices are and we've got – as we've talked about on this call, we have a constrained capital budget with oil in the 60s. It's hard for Alpine to compete with oilier capital in the Permian and in Egypt. So, our view is let's evaluate the performance of the DUCs and then we'll decide or evaluate potential third-party capital.

Neal Dingmann
Analyst, Truist Securities, Inc.

Q

Sure. Makes a lot of sense. And then just lastly, quickly, are you seeing any just OFS whether cost inflation, not only domestically but I'm just curious, internationally, do you see much over on the two plays?

David A. Pursell
Executive Vice President-Development, APA Corp.

A

Yeah. On well capital, so far, the answer is no. We would – we're looking for it. We'd anticipate it. We're looking at steel to see if we see inflation on the OCTG side of it. I think where we're feeling the inflation, and Clay talked about it on the LOE stuff, your basic operating chemicals and diesel costs. So, we're seeing a little more real-time inflation at the LOE level and less at the CapEx level right now.

Neal Dingmann
Analyst, Truist Securities, Inc.

Q

Very helpful. Thanks again for squeezing me in.

David A. Pursell
Executive Vice President-Development, APA Corp.

A

Yes.

John J. Christmann
President, Chief Executive Officer & Director, APA Corp.

A

You bet.

Operator: Thank you. There are no further questions in queue. I will now turn the call back to John Christmann. Sir, please go ahead.

John J. Christmann

President, Chief Executive Officer & Director, APA Corp.

Thank you. I'd like to leave you with the following parting thoughts. Delivery was very good in the first quarter, and we have reiterated our full year guidance. Commodity prices continue to be constructive, and we have clear visibility into at least $1 billion in free cash flow this year. We are seeing the benefits of our diversified portfolio as increasing volumes in the Permian over the next two quarters will more than offset the seasonal planned maintenance downtime in the North Sea.

Activity will also be picking up in Egypt as we move into the back half of the year. We have successfully transitioned operatorship on Block 58 to our partner, Total, with two rigs conducting very active appraisal and exploration programs for 2021. We look forward to updating you on our continued progress throughout the year. That concludes our call today.

Operator: This concludes today's conference call. Thank you for participating. You may now disconnect.

Exhibit 44

In the Matter Of:

In Re Apache Corp Securities Litigation

ZACHARY NYE

November 08, 2023

IN THE UNITED STATES DISTRICT COURT
FOR THE SOUTHERN DISTRICT OF TEXAS
HOUSTON DIVISION

--------------------------------X
In Re:

APACHE CORP. SECURITIES LITIGATION

Civil Action No. 4:21-CV-00575

--------------------------------X

REMOTE VIDEOTAPED DEPOSITION
OF
ZACHARY NYE
Wednesday, November 8, 2023

Reported by:
AYLETTE GONZALEZ, RPR, CLR, CCR
JOB NO. 2023-917845

DATE: November 8, 2023

TIME: 8:30 a.m. (PT)

Remote videotaped deposition of ZACHARY NYE, pursuant to NOTICE, before AYLETTE GONZALEZ, a Registered Professional Reporter, Certified LiveNote Reporter, Certified Court Reporter and Notary Public of the States of New York, New Jersey, Pennsylvania, Delaware and Texas.

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ALSO PRESENT:
BRYAN BELTRAN, Videographer
JORGE BAEZ, NERA
LUCY ALLEN, NERA

THE VIDEOGRAPHER: We are on the record on November 8, 2023, at approximately 8:31 a.m. Pacific Time, for the remote video deposition of Mr. Zach Nye, in the matter of Apache Corporation Securities Litigation.

My name is Bryan Beltran, and I'm the videographer on behalf of Lexitas.

Would counsel please introduce themselves for the record beginning with the party noticing this proceeding.

MR. LAWRENCE: John Lawrence from Baker Botts for defendants, along with my colleague Tony Lucisano.

MR. WHITMAN: Johnston Whitman, from Kessler Topaz Meltzer & Check, on behalf of the lead plaintiffs and the witness, Dr. Nye.

THE VIDEOGRAPHER: Thank you.

Would the court reporter please swear in the witness.

****

Z A C H A R Y N Y E,
called as a witness, having been duly sworn by a Notary Public, was examined and testified as follows:
EXAMINATION BY
MR. LAWRENCE:
Q. Good morning, Dr. Nye. How are you?
A. I'm well, thank you. Good morning to you.
Q. Good morning.
Do you have any materials with you today?
A. I was told to print out my two reports and Ms. Allen's two reports.
Q. Great. Thank you.
Anything else?
A. No.
Q. Great. Why don't we go ahead, and those will probably be documents we refer to often. I'll go ahead and mark those.
We'll mark as Exhibit 1, the April 7, 2023 report of Dr. Nye. As Exhibit 2, the June 16, 2023 report of Lucy

Allen. As Exhibit 3, the August 11, 2023 reply report of Dr. Nye. And as Exhibit 4, the September 8, 2023 surreply report of Ms. Allen.

(Nye Exhibit 1, Expert Report of Zachary Nye, Ph.D., dated April 7, 2023 was marked for identification, as of this date.)

(Nye Exhibit 2, Expert Report of Lucy P. Allen, dated June 16, 2023 was marked for identification, as of this date.)

(Nye Exhibit 3, Expert Reply Report of Zachary Nye, dated August 11, 2023 was marked for identification, as of this date.)

(Nye Exhibit 4, Surreply Report of Lucy P. Allen, dated September 8, 2023 was marked for identification, as of this date.)

BY MR. LAWRENCE:

Q. Dr. Nye, have you given -- provided an expert report on behalf of a party represented by Kessler Topaz before this one?

A. Yes.
Q. How many?
A. Two come to mind. There might be a few more.
Q. Great. How about Saxena White?
A. I don't believe so. They may have been co-counsel on some other project I worked on, but I don't believe I've worked with them directly towards a report for -- in federal court.
Q. What are the two you recall from -- where you represented a party or where you gave a report on behalf of a party represented by Kessler Topaz?
A. Heckmann Corporation Securities Litigation, I think is the title of it. I also did a case where there was direct action plaintiffs versus Merck. Another comes to mind now, Snap Securities Litigation. And Advanced Auto Parts. I think those are the four.
Q. And were any of those four also reports on market efficiency or price impact?
A. Some of them were. I could

think, try to remember which ones exactly if you want.

Q. If you recall.

A. Heckmann, I believe I did market efficiency, an opinion on market efficiency that is. There might have been a damages opinion similar to that in this case. That was a while ago, so it might have been before Comcast was an issue and those types of opinions being requested.

Snap, I did talk about market efficiency for sure. I think there was a price impact challenge, but I didn't have an affirmative opinion on that, I think at the beginning. That one also went into the merits phase.

Merck was calculating damages for specific clients using I think a price inflation measure provided by the class expert.

And then Advanced Auto Parts, there was market efficiency, and yeah, I think there was a price impact challenge that I responded to there as well.

Q. Thank you.

Dr. Nye, you understand that Ms. Allen has opined that she sees no evidence of any of the alleged inflation coming out of Apache's stock during what she calls the focus period?

MR. WHITMAN: Objection to form.

A. I am aware of her opinions, yes.

Q. Okay. I want to start looking at Ms. Allen's surreply report, which is Exhibit 4, if you'll look at paragraph 19.

A. Is that going to be dropped into the Lexitas exhibit share?

Q. It's going to be dropped into the chat.

A. The chat, okay.

Q. Yeah.

A. While I wait, you said paragraph what?

Q. Paragraph 19.

MR. LAWRENCE: Tony, if you want to go ahead and drop in all the first four.

MR. LUCISANO: Okay. I'll drop

the other three as well.
MR. LAWRENCE: Thank you.
Q. Would it be helpful for Tony to put it up on the screen, Dr. Nye, would you rather look at it on paper? I'm happy to do whatever is easier for you.
A. I'm just going to try to --
Q. Open it yourself?
A. Open this sucker, yeah. Open file, let's see if that works. There we go. Okay. You want me to go to 19. I am there.
Q. Okay. So Ms. Allen says in her second sentence, "Since the alleged inflation (if any) did not come out of Apache's stock price during the Focus Period," and I believe that you disagree with her conclusion that it did not come out of Apache's stock price; is that right?
A. Well, I mean she's performing a damages analysis, loss causation analysis, that's not the same thing as a price impact analysis here. So my replies to her opinions really involve what I consider to be a failure to demonstrate a lack of price

impact associated with the alleged misrepresentations.

Q. Okay. Do you then in your report, in either of your reports, do you dispute that the alleged inflation, if any, did not come out of Apache's stock price during the focus period?

MR. WHITMAN: Objection to form.

A. Well, I -- first off, my understanding is that's a merits issue and requires an analysis of loss causation, which is, I believe, improper given that discovery is still ongoing.

I think there's evidence based on my research related to her or written responding or replying to her so-called price impact opinions, which really are damages analyses, that, you know, materially, the information came out on the alleged corrective disclosure dates and there appears to be price changes that are unconfounded in response to those. So I think that's -- to opine that there's a lack of price impact associated with those

disclosures, they didn't call the price change, a whole lot more work needs to be done by Ms. Allen.

Q. If we can, looking back at paragraph 19, and Ms. Allen's second sentence, if we can assume for the moment that it is correct, that Ms. Allen is correct that the alleged inflation did not come out of Apache's stock price during the focus period, I want you to then look at the three possibilities she gives, and let me know if you agree that again, assuming that she is correct, that the alleged inflation did not come out of Apache's stock price during the focus period, is it then correct that either, one, the pre-focus period alleged misrepresentations had no impact at all; two, the alleged inflation from the pre-focus period alleged misrepresentations came out of Apache's stock price before the focus period; or three, the alleged inflation was still in the stock after the alleged class period?

MR. WHITMAN: Objection to form.

A. The first bullet point, based on what I've seen and described in my reply report, is that the alleged misrepresentations appear to have strongly impacted the price of Apache stock. You can see that at the opening of the class period, when the price increases in a statistically significant manner, basically all the analysts describe and repeat the alleged misstatements regarding Alpine High being a world class resource, an immense resource, driving growth and returns for many, many, many years to come and being profitable at very, very low commodity prices.

So no, I don't agree with this even if you were to assume something that hasn't been established in any way, shape or form.

Q. So you mentioned the first one she list and you don't agree that roman numeral number I is a possibility. How about Roman numerals II and III, do you agree that again, if it is true that the alleged inflation did not come out during

the focus period, then I guess now we're left with two options, that either ii, iii are what occurred?

MR. WHITMAN: Objection to form.

A. I mean it's -- if the assumption is that there's no price inflation removed or dissipated during the focus period, yeah, that's not what plaintiffs are alleging, but sure, if you assume that, then that doesn't tell you anything about the inflation present during the pre-focus period.

So I don't think two is necessarily true either because you don't know, nobody's analyzed yet whether the alleged inflation came out before the focus period. But three, yeah, if you assume there's no corrective events that caused the price to decline in a manner that dissipated price inflation, then there would or could be price inflation remaining, but that's not plaintiff's theory of liability.

Q. I understand that. So I just

want to make sure I understand your response to what Ms. Allen is saying here. I know you don't agree that she has established that no inflation came out during the focus period, but in the hypothetical where -- where -- where the court does decide that no inflation came out during the focus period, in your view, that must have happened is iii?

MR. WHITMAN: Objection to form.

A. I'm just -- with number ii, I'm just saying that nothing has been established that the price inflation came out. iii is a tautology based on the hypothetical that you've asked me to assume.

Q. So do I understand you correctly that in the world where we assume it's true that no inflation came out during the focus period, that you would agree that either ii or iii are what occurred, but you're saying that there hasn't -- no one has done the analysis or assessment to determine which of those occurred?

MR. WHITMAN: Objection to form.

A. Effectively, yes, and that's my point in the reply report is that Ms. Allen has not established that any three of these -- well, I may have established number one is false and then the other two, yeah, she hasn't attempted to estimate the level of price inflation, how it evolved, and that's not even the point here, we're a class cert, so we're accessing price impact. There appears to be strong evidence of price impact associated with the alleged misrepresentations.

Q. Other than these three possibilities, again, assuming that no alleged inflation came out during the focus period, is there a fourth or fifth possibility?

MR. WHITMAN: Objection to form.

A. Maybe. There's a lot of hypotheticals you could think of, I suppose.

Q. Any that you can think of?

A. Not at the moment.
Q. What is statistical significance?
A. I describe it in my report. It is in this context, really just a different scaling of company specific returns. Statistically significant returns, a given threshold would be relatively rare occurrences that you will only see, say, ten percent or five percent or one percent of the time depending on your cutoff. So in absolute magnitude, the most extreme returns, you're likely to observe given the control period that you've used to estimate the regression model.
Q. What in your view is the relevance of statistical significance in this setting?
MR. WHITMAN: Objection to form.
A. Again, they describe the frequency with which you're likely to observe certain returns.
Q. If returns are described, are identified as statistically significant,

what does that mean?
A. They're, as I stated, relatively rare returns, depending on the cutoff you use or the researcher uses to establish statistical significance. If they use a ten percent cutoff, so it's significant at the 90 percent confidence level or the ten percent significance level, which are the same term -- the same thing stated slightly differently. You only likely to see those returns of that size about ten percent of the time or less.
Q. Looking at your reply report, which is Exhibit 3, I'll point you to paragraph 67. Let me know when you're there.
A. Paragraph 67 of my reply?
Q. Yes, please.
A. I'm there.
Q. Okay. Great.
Okay. Starting here at the second sentence, you say, "Rather, contrary to Ms. Allen's blind acceptance of the null hypothesis, given the low statistical power of single-firm event studies, it is

entirely plausible that the null is false -- but, by chance, the data happened to be of the kinds expected under the null."

What does it mean for the null to be false? Explain that to me.

A. On this setting, Ms. Allen's null hypothesis is that the corrective disclosures have no effect on the stock price. So if the null is false, that means that the alleged corrective information does have an effect on the stock price.

Q. And then in your -- in your next sentence, you say, "Indeed, when a study with low power fails to show a significant effect, the results may therefore be more fairly described as inclusive" -- "as inconclusive than negative. The proof is weak because the power is low."

What does -- what does the concept of low power or high power here?

A. So I think power is the -- I described this in paragraph 65 of my report, and single-firm event studies have

low statistical power and are thus prone to accepting the null hypothesis when the alternative hypothesis is true; in other words, prone to making type two errors.

Q. So what is -- what is -- just define power for me; what do you mean by "power"?

MR. WHITMAN: Objection to form.

A. Power is the ability of the statistical analysis to find effects when they exist, when they're true, when they're truly there.

Q. And why do you believe Ms. Allen's event study is low power?

A. My comment here is single-firm event studies, which is what she's done here. And typical, I do it for the market efficiency analysis as well, just as a matter of fact or relatively low powered regression analysis as compared to your larger more cross sectional studies that are popular in the academic literature and it's just a sample size problem. When you've got, you know, a thousand companies

that you're studying, you are able to hone in basically eliminate a lot of the estimations or surrounding certain corporate events that you're examining. And so you get much standard errors and you're more capable of detecting true effects when they exist.

Single-firm event studies though are based on a single company looking at a single day and so it's well documented that they do have relatively low power and they are prone to accepting the null hypothesis when the alternative hypothesis is true.

Q. And when you say they have relatively low power, sounds like what you're saying is they have a lower power than -- than an event study with a larger sample size, is that what you're saying? When you say "relatively," relative to what?

A. I said exactly that. So having more, a larger sample of events you're examining across a number of larger number of firms, basically allows the competing

company specific volatility to cancel out across that sample and so you're really able to hone in on the specific corporate events that you're examining, which is not specific to one firm. It's across all the firms you're examining.

Here though, in a single-firm event study, really the problem is that we're using a -- the residual returns to estimate through the regression framework, the standard error of the estimate. And those are companies -- residual returns are just net of market industry effects, so you're using the entire history in your control period of corporate events that are, say, earnings announcements or other important company specific events that change the company's stock price.

And those are -- that's not really the -- that's kind -- when you're examining another day, what you're concerned about is whether there's some kind of noise or transactions costs that are -- that you want to filter away. So the -- that noise and I think

Grossman-Stiglitz paper describes this pretty well is that it really kind of -- and the Noise paper by Fischer Black, describe how transactions costs and information gathering costs can create a bound around fundamental value, that it wouldn't be profitable to trade under, because you can't make profits greater than the transactions cost or information gathering cost.

So that little bound which becomes smaller, and smaller, and smaller as the market becomes more efficient is really what we're trying to prevent that noise from being -- any price movement that's occurring within that bound, from being attributed as the cause or disregarded as the cause for the price change.

But using the company specific residuals in the whole example is a much bigger standard error than that. Just that noise band. So ideally you would remove all news days in your control period, but that's not done frequently.

Q. So using a single firm model, are you unable to renew -- remove that -- that noise you talked about to disregard the noise and actually determine the cause of the price change?

A. Yes. I mean, you've got -- I've also established market efficiency. So here, the price is responding to fundamental information, material information. It's not -- it's not changing because of, you know, transactions costs, which are very tight. I mean, like the bid-ask spread for Apache is like $0.01, so it's -- that's not something to be concerned with.

Q. And is that -- is that -- trying to think of the word. Is that flaw or is that deficiency in single firm models true for all single firm studies?

A. I mean, it's that relative -- relatively lower power is always there for all single-firm event studies and that's why if you see a statistically significant result, it means it's a huge return. You cannot worry at all about it not being

cause by anything else. It's just kind of a conservative threshold that courts apply.

But in an efficient market, even small price changes are caused by the information disclosed. So sometimes, information doesn't have a huge effect on a stock price, but it still caused it to change in an efficient market.

Q. In paragraph 67, in the two sentences we were looking at, you're citing to something called the Reference Guide on Statistics; what is that?

A. It's a big primer online. My understanding is that it's to assist federal judges assessing evidence.

Q. Something that you cite often in your reports?

A. I have, yes.

Q. And then if we look back at page -- that's a couple pages to footnote 217, we can see that the Reference Guide on Statistics looks like it's inside of a larger work called the Reference Manual and Scientific Evidence; is that right?

A. That's right.

Q. And the Reference Guide on Statistics looks like it was authored by David Kaye and David Freedman. Do you know them or know of them?

A. I guess from this section in the Reference Manual on Scientific Evidence.

Q. Why do you choose to cite to this particular source thread than -- I assume there are other pieces of literature that say similar things. Why do you use this Reference Guide on Statistics?

MR. WHITMAN: Objection to form.

A. I cite to many references in this section, not just this one, but this is -- my understanding is that it's, as I said, a reference manual or guide or primer for assisting federal judges to weigh this type of evidence.

Q. And in looking at it in the past, in connection with this case, you found it helpful?

A. Yes.

Q. Accurate?

A. Accurate enough. I mean, I may not agree with every single way they describe everything, but it -- it is a good source.

Q. What's -- I want to turn you to this chapter.

MR. LAWRENCE: Tony, if you can drop in as Exhibit 5, the Reference Manual on Scientific Evidence, chapter on Reference Guide on Statistics.

A. I have it open.

(Nye Exhibit 5, Reference Manual on Scientific Evidence, Third Edition was marked for identification, as of this date.)

BY MR. LAWRENCE:

Q. Then if you could turn to page 254, which is the page you're citing to in your paragraph 67 of your report.

A. Okay, I'm there.

Q. And then in the second paragraph, it starts with one of the sentences you were quoting in your paragraph 67, the sentence says, "When a

study with low power fails to show a significant event, the results may therefore be more fairly described as inconclusive rather than negative. The proof is weak because power is low." Do you see that?

A. I do.

Q. Then the next sentence in this chapter says, "On the other hand, when studies have a good chance of detecting a meaningful association, failure to obtain significance can be persuasive evidence that there is nothing much to be found." Do you agree with that statement as well?

A. I think it depends on the context. If you're in an efficient market, I don't think that statement is really valid. Prices in an efficient market change because of the information set changes and it changes the investor expectations with respect to the cash flow prospects of the firm under examination or being priced.

Q. Why would that mean that as these authors say, when studies have a good

chance of detecting full association, failure to obtain significance in your view would not be persuasive evidence?

MR. WHITMAN: Objection to form.

A. I just -- it's depending on the statistical experiments that has a built-in amount of random error is different, like, you're drawing a -- you're rolling dice or, you know, trying to calculate probabilities of how many balls in an urn are blue or black or whatever. That will have a certain amount of random chance assigned to it, quite a bit actually.

And here though in an efficient market, there -- randomness except on the very fine margins of transaction costs isn't what's influencing the stock price.

As I described earlier, we're using a control period to estimate the company's specific return volatility, which is basically using all that company specific information and not how it changed the prices in that control period to kind of try and wash away what we see as our

objective price changes due to changing information overtime.

So it's not as random a process in an efficient market as maybe what these authors have in mind regarding other statistical experiments. So I guess here, because it's a single-firm event study, you are handicapping yourself by not -- by not appreciating the fact that this is an efficient market and the statistical significance threshold really becomes more of a conservative threshold that I understand courts impose, but it is not imposed by the theory of financial economics.

Q. So I understand that you're saying that because it's a single-firm event study, it has low power and can't show this. I'm trying to set that aside.

I'm asking you if an event study did have a good chance of detecting a meaningful association, are these authors right, that failure to obtain significance can be persuasive evidence that there's nothing much to be found?

MR. WHITMAN: Objection to form.

A. I don't think this sentence applies to an efficient market return process, return generating process. I think this has more to do with more statistical experiments. So I think really the issue here is or my disagreement is just with respect to what do they have in mind by good chance of detecting a meaningful association, because that's a really vague statement.

Q. Right. But so is it your problem with whether or not an event study in an efficient market ever could have a good chance of detecting an association that's meaningful?

MR. WHITMAN: Objection to form.

A. In an efficient market, you just look at the price change, that's the value of the information disclosed, and you can net out the regression analyses market industry effects, try to isolate or estimate the component that's due to

company specific effects.

And if you want to apply a threshold for statistical significance, which some courts do, then that is a conservative limitation on usually damages, but that's for the courts to decide, that's a legal issue.

Q. So is this -- is this last sentence of this paragraph that we read together, is that in your view wrong?

A. No. It's just a very vague sentence and trying to apply it to a single-firm event study here, I think is going to require more specification with respect to what they mean here, because I don't know.

Q. Do you think it's more vague than the sentence before it?

MR. WHITMAN: Objection to form.

A. No, I mean, I do think it's more vague than the sentence before it. The sentence before it is very true. It's clear. You cannot accept the null hypothesis of no effect based on a finding

of statistical insignificance.
And I've clearly shown that. It's a well-known fact. I've cited numerous sources to support that and many courts have recognized that.
Q. Explain to me what it is about event studies in an efficient market in particular that makes this last sentence of this paragraph inapplicable in your mind?
MR. WHITMAN: Objection to form.
A. What do they mean by meaningful association, in the context of a single-firm event study. It's not clear to me.
Q. Anything else?
A. What is their threshold for significance? I don't see that defined anywhere. Is it 30 percent?
Q. Anything else?
A. There could be. That's all that comes to mind right now.
Q. It's a 20-word sentence. You could take a minute.
A. There's nothing much to be

found mean there's no effect, even if I make the assumption that they're talking about no effects and whether there's price impact which I don't think they are. So I think that pretty much -- those are my current concerns with the sentence here.

Q. You have no similar concerns with the prior two sentences?

A. The prior two sentences are based on -- let's look at the -- I mean, the prior two sentences also have footnote 106, which is -- well, it's describing how the -- they use -- because alpha and beta, which are the parameters in the power analysis. Yeah, okay. Type one, type two errors. Do not give the probabilities of the null of an alternative hypothesis. That's -- I think Ms. Allen agrees to that.

So I mean, there's more description here to describe why -- I guess the paragraph before, excuse me. And then my report, I describe obvious, you know, counterfactual or incorrect inferences that can be made if you were to accept a null hypothesis based on an insignificant

result, because sure, you might not be able to statistically distinguish, you know, the residual return from zero.

But you also can't distinguish it from whatever else is within the 95 percent or 90 percent confidence interval, which will include even more negative returns and I make that point, so it's an obvious fallacy to accept a null hypothesis based on a finding of statistical insignificance.

Q. When we talk about low power -- when you talk about low power, when this article talks about low power, your response is you kept telling me, you know, relatively low power. I want to understand better.

Setting aside whether or not something is low power relative to something else, how do you determine -- is there a measurement, is there a number I look at, how do I determine what is low power?

I mean eight is relatively lower than nine, but eight out of ten is

still pretty high. So how do I know -- how do I measure if something is low power, not just relatively low power?

MR. WHITMAN: Objection to form.

A. Statisticians are common frictions run simulations of these regression frameworks and estimate the power of the function or the test.

Q. And do you know where single-firm event studies fall on that scale?

A. On the scale of the power of a given test here is not -- it's the test that has power, right. It's not the application of the test. So again, relative to cross sectional studies, which have a larger sample of firms being examined, they are lower power, so that's the -- a well-known finding.

Thus while you -- in academics, we place a lot of emphasis on statistically significant results and large cross sectional study, the point is that it's not -- I think the Petrobras court has a quote

to that effect. It's -- you can note the size of the return, but just because it's insignificant doesn't necessarily mean it's immaterial or economically just as a matter of dollars and cents, that is important and significant.

I mean here, I mean what are we talking about. We're talking about March 16, 2020, the company's stock price declined 22 percent on that day. Even net of market industry effects, we're looking at north of 15 percent. I think it's like 20 percent across the two days. That's obviously economically significant. That's a huge negative return that you'll almost never see.

Q. So other than -- you kind of again described single-firm event studies as lower power than cross sectional. I'm trying to figure out, I mean, if my daughter gets a 98 on a math test and her friend gets a 99, she had a lower score than her friend, but I wouldn't say she got a low score.

So if you can explain to me --

I understand that one test in your view may be better than the other, but that's different than what you're saying in your report, which is that single-firm event studies are low power. How do you -- how do you define or measure that, that they are low power?

MR. WHITMAN: Objection to form.

A. So the power of a test, again, is established by academics and one finding is that -- I cite the Carpenters' opinion, which summarizes -- well, not Carpenters'. What is it? Yeah, it is. It's Carpenters Pension Trust Fund of St. Louis versus Barclays from 2015. And this is describing the findings of an academic paper and it's showing, you know, quantifying how single-firm event studies are -- do have lower power as a matter of fact, relative to cross sectional studies or events, cross sectional event studies.

Q. In your view, are cross sectional event studies always higher power than single company event studies?

A. I -- you know, probably. I haven't researched it in an exhaustive fashion lately, but I think it's probably true, that it's all else equal, that, you know, having more firms to -- which allows you to cancel out across the firms, the company specific information on the dates of interest that are uncorrelated. I think that does increase the power relative to single-firm event studies.

Could there be some possible situation in which it is lower power, maybe. I don't know.

Q. When one study is lower power than another study, does that always make the study that is lower power a "low power study" as defined and used in this reference manual in your report?

MR. WHITMAN: Objection to form.

A. Can you repeat the question, please.

Q. Sure. When one study is lower power than another study, does that necessarily mean that the lower power study

is a "low power study" as you use that term low power in your report and as it's used in this reference manual?

MR. WHITMAN: Objection to form.

A. I think just specific to single-firm event studies, they are low power in the sense that when you -- I mean, we can see exactly the residual returns and we know -- we're just basically assigning a cutoff when we use a 95 percent confidence level. That is cutting off the -- in Ms. Allen's world, the possibility that any return outside of the most infrequent and large returns could possibly have had a price impact. That is just not true in an efficient market.

Efficient markets prices change because of the information disclosed. That is the definition of an efficient market. So yeah, I think that failing to acknowledge returns that are, say, more frequent than only occurring, say, five percent of the time, results in a lot of false negatives in the context of power

analysis.

Q. Let's -- I'm going to look at the EZCORP opinion that you cite in your reports.

MR. LAWRENCE: Tony, if you could please drop that in, we'll mark that as Exhibit 6.

A. Okay, I'm there.

(Nye Exhibit 6, Rooney v. EZCORP, Inc. Opinion was marked for identification, as of this date.)

BY MR. LAWRENCE:

Q. Great. Do you recognize this opinion?

A. I mean, I know of the opinion. I don't know that I've got it in this form.

Q. You've read it before though?

A. Yes.

Q. If you could turn to page 12 of the actual document, of the PDF.

A. Sorry, what page?

Q. 12 of the PDF.

A. Okay. I see it highlighted.

Q. Great. So looking at this highlighted paragraph, the court says,

"Here, Plaintiff's expert, Chad Coffman, submitted an expert report indicating the two corrective disclosure dates at issue here returned p-values of 0.234 and 0.233, respectively. These p-values suggest there is a 77 percent chance the corrective disclosures identified by Plaintiff negatively impacted EZCORP's stock price on these dates."

That second sentence I read, where the court says, "These p-values suggest there was a 77 percent chance the corrective disclosures identified by Plaintiff negatively impacted EZCORP's stock price on these dates," that's wrong, right, scientifically, academically?

MR. WHITMAN: Objection to form.

A. Yeah, I --I've seen this interpretation of it before. I don't think it's correct. As I describe, it means that there's -- the P-values describe the conditional probability of observing a return as great or greater in terms of absolute magnitude, but yeah, that's it.

Q. And the conditional probability for observing a return is not the same as the likelihood that the effect being tested is true, which is what the court is doing here, right?

MR. WHITMAN: Objection to form.

A. I don't know what the court means by this. I don't think the court's a statistician or the judge was or is a statistician. I can't speak for the judge, but the conclusion of this is it's still valid of the overall -- of the overall, yeah.

Q. But I'm just asking you, the court's conclusion "These p-values suggest there was a 77 percent chance the corrective disclosures identified by Plaintiff negatively impacted EZCORP's stock price on these dates," that conclusion is not valid, correct?

MR. WHITMAN: Objection to form.

A. I'm sorry, you wanted to know whether -- sorry, please repeat the

question.
Q. Sure. Happy to.
So the court's conclusion in this paragraph when the court says, "These p-values suggest there was a 77 percent chance the corrective disclosure identified by Plaintiff negatively impacted EZCORP's stock price on these dates," that conclusion is not valid?
MR. WHITMAN: Objection to form.
A. It's -- it's a misinterpretation I think of -- of the theoretical argument underlying P-values and statistical significance. I do note there's plenty of correct stuff in this -- on this page that's properly construed and quoted by this court regarding the inapplicability of statistical significance or insignificance to find a lack of price impact.
Q. When you say that this one conclusion that we're talking about right now was a misunderstanding of the argument, you're saying it's wrong, right, it's

statistically wrong?

MR. WHITMAN: Objection to form.

A. It's wrong. I don't think it has any effect on the ultimate conclusion that makes -- is improper to determine that there's no price impact based on a statistically insignificant result.

Q. As you said, and I assume you're right, this judge is not a statistician?

A. I don't think so. I don't know really. I'm assuming.

Q. I'm also making that assumption personally. But not surprising -- not surprising that someone who's not a statistician might make a mistake like this? This is a fairly -- not surprising to you that someone who's not a statistician could make a mistake like this?

MR. WHITMAN: Objection to form.

A. It's not that surprising to me, no, you're right.

Q. Dr. Nye, you also performed an event study in connection with your first report, Exhibit 1, correct?

A. Yes.

Q. And you used that event study to analyze market efficiency and to test whether new value relevant information was rapidly incorporated into the price of Apache's stock, right?

A. Yeah, to determine whether it was a cause and effect relationship between earnings related disclosures and Apache's stock price.

Q. And in responding to Ms. Allen's first report in your reply report, you used that same event study to analyze price impact and test the significance of Apache's stock price return on April 23, 2019?

A. I used the regression model underlying my event study, which I used to assess the cause and effect relationship under Cammer 5.

Q. It's the same event study you used in your first report and that you used

in your second report in responding to Ms. Allen's opinions on the significance of the impact on April 23rd?

MR. WHITMAN: Objection to form.

A. I want to be clear, it's not the same event study because I'm studying different events. It's the same regression model.

Q. And that event study or those event studies in those two reports that you used, those are also single firm studies?

A. Yes.

Q. And so the studies that you've performed in this case are also low power?

MR. WHITMAN: Objection to form.

A. Yes, they have low power relative to cross sectional event studies that have a larger sample of firms and events under study, however, my opinion on the cause and effect relationship is not solely due to the prevalence of statistical significant returns or -- sorry, statistically significant returns. It has

to do with the event study carefully chronically and appreciating what was disclosed and how it was reacted to by investors and analysts, and observing whether the return, that of market and industry effects is consistent with the totality of the company specific information disclosed on that day.

Q. You're saying, I think, your event study was not the sole basis for your opinion, but it formed -- it was some evidence that helped form the basis of your opinion?

A. No. I'm -- within the regression or event study associated with earnings related disclosures by Apache during the class period, I'm carefully lining up what was disclosed, how it was received by the market, and then whether that information, how it was received was consistent with the magnitude and direction of the price change, net of market and industry effects on those dates to establish whether it's a cause and effect relationship.

It's not enough just to look at statistically significant dates. You have to know what the information is and how it impacted the stock price.

Q. So it's not enough just to look at significant dates, but what you did in your event study does form part of the basis of that opinion?

MR. WHITMAN: Objection to form.

A. I think we're using -- you might be using the term event study broader than I am.

Q. Okay.

A. I mean, I conducted a study of events, which is a number of earnings related dates during the class period. I used the regression model as part of that event study to disentangle or control for market and industry related influences on Apache's stock price on those dates, thereby leaving me with an estimate of the company specific price change on the earnings dates.

I then looked at the news, what

was disclosed, how it was received, whether it was any change to expectations, any surprises, any misses, and chronicle how the information on that -- those dates are consistent with the direction and magnitude of the returns, net of market and industry effects on those earnings dates.

Oh, and the other thing was there's insignificant dates. Those -- to me, that doesn't mean it's evidence of market inefficiency, no. There's good reason for there to be an insignificant date when not much is disclosed or something that's got good and bad news, they kind of offset each other, that can be and is an irrational and efficient market response in those instances.

Q. The regression model you used is a low power single firm model?

A. It's low power if you're going to accept the fallacy that a statistically insignificant return means there's no effect. I mean, it's pretty ridiculous, right, to say that it's a statistically insignificant return. But even though it

went down, say, six percent, it's not 95 percent significant. I'm just going to assume that the return was zero then. That's not at all what happened.

It might have gone down six percent. That's how much the information was worth on that day. That's kind of my point.

Q. Let me just ask maybe a more direct question. Explain to me why it is appropriate for you to use a low power single firm event study to conclude as part of your basis, to help you conclude that information was rapidly incorporated into Apache's stock price in your first report?

MR. WHITMAN: Objection to form.

A. Because I'm using the regression model to control for market and industry effects and then the confidence level just tells me on a different scale how big is the return observed in terms of absolute magnitude, how extreme is it. That's all it's telling me.

But I'm still fundamentally

having to go in and look at the news, it was disclosed, how it was received and whether that's consistent with the direction and size of the return.

Q. Why didn't you use a cross sectional higher power model?

A. Not even a possibility. We're examining one company. It has to be Apache.

Q. So when you're looking at one company, the best you can do is a single firm model?

A. Right.

MR. WHITMAN: Objection to form.

Q. You also in your -- in your first report, Exhibit 1, talk about your proposed common damages methodology, paragraph 67 of your first report if it's helpful to look at. Somehow in two reports, we're looking at the same paragraph number back-to-back.

In your first report, in discussing your common damages methodology, you say, "an event study can be used to

isolate company specific price movements caused by the revelation of true facts related to the alleged fraud from price movements caused by other factors."

That would also be a single-firm event study, correct?

A. Right. And the low power has no bearing on the ability of the model to estimate reliably and scientifically the market and industry components to that return. That's not at all what we're talking about.

We're talking about whether having an arbitrary cutoff of 95 percent allows you to accept the null hypothesis that there's no effect if the return is insignificant.

Q. The single-firm event study that you posed to use the common damages methodology, that in your view could not detect whether company specific price movements were caused by the revolution -- revelation of true facts related to the alleged fraud or from price movement caused by other factors, right?

MR. WHITMAN: Objection to form.

A. Definitely. Absolutely can, because it's an inefficient market and you just look at the price change net of market and industry effects, which are I think it's a best linear unbiased estimator of those effects in statistical jargon. And so in an efficient market, that's how much the information was worth.

All statistical significance having some threshold is telling you is it a big return. Is it so big or so negative usually in these context, that you would only expect to see it 2.5 percent of the time because the other 2.5 percent is on the top end, which we ignore. So these are extremely rare returns that you limit the analysis to if you just say it has to be significant at the 95 percent confidence level.

Q. Then I -- then you would agree that Ms. Allen's study from her reports also can be used to isolate company specific price movements caused by the

revelation of true facts related to the alleged fraud from price movements caused by other factors, right?

MR. WHITMAN: Objection to form.

A. Right. And I make that point. I actually show how similar point estimates are of the residuals. They're very negative. What we're talking about is this kind of arbitrary construct that is false, that you can now say that there's no price impact, that nothing happened, because it's not statistically significant. That's just not true.

Q. Is the fact that it's not statistically significant provide any evidence or any weight in favor of a conclusion that the movement was not caused by that news?

MR. WHITMAN: Objection to form.

A. Well, I mean as an economist if it wasn't that, then why don't you go find out what caused the price decline and I don't think Ms. Allen bothered to do that

on any of the dates.

As a matter of law though, I mean if courts can assign conservative thresholds, my understanding is that they have in certain cases. It's got to be 95 percent confidence level for the decline to be actionable under the federal securities laws. That's not opinion, but some courts I think have said something like that. Others have not.

I've heard of other cases where there's no threshold of significance applied, which I think is consistent with financial economics and market efficiency. Again, prices change because information is revealed over time and investors update their expectations about the cash flow prospects and risk of the firm. I guess that's it.

Oh, I know what I was going to say. It's meaningful in the sense that it tells you how rare the return is given the control sample. So I don't think it's meaningless in any way. It's just that how you want -- how hard do you want to push

that because it certainly doesn't mean if it's insignificant, there's no effect.

Q. When you say it's meaningful in the sense that it gives you -- tells you how rare the return is, what does that tell you? What does the fact that the return is rare tell you?

A. The size of it relative to the control sample. Is it -- I mean, again, we're talking about negative returns usually, so is it -- one of the most rare returns, if it is, the most negative returns that you're likely to see, then that's -- it might be something that the trier of fact would want to weigh.

As an economist, I'm trying to provide helpful economic evidence, but I'm not the trier of fact, so as far as what the thresholds apply, that's up to them.

Q. As an economist, do you think that a lack of statistical significance gives any weight toward the conclusion of whether or not a particular piece of news impacted the stock price?

MR. WHITMAN: Objection to

form.

A. It depends on the context. When you have nothing else that could possibly explain a return though, efficient market hypothesis, and as I've demonstrated and it's not challenged in this case, implies that even statistically insignificant decline is caused by the unconfounded information disclosed, and that is a matter of economics.

Q. You said I think when you have nothing else that could possibly explain a return, no, is that....

A. Maybe I didn't answer it the way I should have. What was the question then?

Q. I don't remember.

A. I think I got the point across, but....

MR. WHITMAN: There's no question.

Q. As an economist, is lack of statistically significant some evidence that in connection with other evidence could provide some weight toward a

conclusion that the market was not reacting to the studied event?

MR. WHITMAN: Objection to form.

A. Sure. It provides some evidence. Like I said, it's a measure of how large and absolute magnitude that return is and also how rare or infrequent that return is with respect to the sample you use to estimate your regression model. So it's some evidence of the impact of a -- an event.

Q. Let's talk about how you build an event study.

MR. WHITMAN: John, if you don't mind, if you're changing topics, we've been going about an hour 20. Can we take a five-minute break?

MR. LAWRENCE: Yeah, that's fine.

MR. WHITMAN: I appreciate it. Okay.

THE VIDEOGRAPHER: Okay. The time is 9:53 a.m. and we're going off

the record.

(Whereupon, at this time, a short break was taken.)

THE VIDEOGRAPHER: The time is 10:00 a.m. and we're back on the record.

BY MR. LAWRENCE:

Q. Dr. Nye, can you please explain to me the difference in statistical methodology between estimating price impact and damage per share?

MR. WHITMAN: Objection to form.

A. The regression model is usually how it's done. I haven't done that in this case. Sometimes it changes from class cert phase to the merits phase, but usually, it's stays pretty similar. And so it's going to be a single-firm event study like we've been talking about here, which usually controls for market industry effects. Sometimes there might be an -- other variables in the model.

Q. In terms of the model you would use and the methodology you would use to

estimate damage per share as part of damages versus what you would use to estimate price impact, how do they differ?

MR. WHITMAN: Objection to form.

Q. If at all?

A. They won't probably differ by much. I mean, it can, of course. I just -- to be careful, it might change significantly, I guess, but typically it's going to be a single-firm event study because you're basically concerned with the company specific returns that of market industry effects, specific corrective disclosure dates.

Those are again reliable scientific well-founded and accepted methodologies to estimate those company's specific returns which form the estimate of price inflation and damages typically and can also be informative about whether the alleged misstatements had price impact overall.

Q. So the methodology is used for price impact and damages per share, don't

need to differ at all, right?

A. They might need to, that's what I'm saying. They sometimes don't, across the two phases of the case.

Q. Why might they need to?

MR. WHITMAN: Objection to form.

A. Just depends on who's doing the analysis, right. I mean it could be that like take, for instance, here, Ms. Allen has her own regression model and I have mine and maybe another one will be developed down the road to help isolate a component of the -- of a return that's due to the fraud as opposed to other factors, which is a damages and loss causation issue that I have not analyzed to date. So it's just a matter of being careful that things can change as discovery proceeds.

Q. At this stage, if you were to perform an analysis of damage per share, you would do it in the same way as you would do price impact?

MR. WHITMAN: Objection to form.

A. I don't know that I would. I haven't been asked to do it, so maybe I would, maybe it would be the same regression model, but I don't know for sure.

Q. There's no reason why the two methodologies necessarily need to be different, but because they're being performed at different times and possibly by different people, they could be different; is that fair?

MR. WHITMAN: Objection to form.

A. Yeah. I mean, you know, I've got -- I've worked on these matters before and sometimes, say, there's a motion for summary judgment and the part of the case is tossed or thrown out, so you've got to now readjust your models maybe.

Q. If a -- if an event that's in the case now is not in the case a year from now, that might -- that would impact what your model would need to look like, but barring changes in the, you know, posture of the claim, and the substance and

contours of the claim, there's no need for different methodology for the two estimates?

MR. WHITMAN: Objection to form.

A. You know, I'm not 100 percent sure you're covering all the bases, so I'm hesitant to say they're always the same. I don't think I'm -- I'm not saying that they're frequently different. I'm just hedging a little bit. You know, it's a regression model. It's a single-firm event study, and if you've got confounding news that's unrelated to the fraud, you have to disentangle it. That's the name of the game.

The point -- I'm not going to volunteer this. Okay. Go ahead.

Q. Let's look at your first report, Exhibit 1, page 30.

A. Okay.

Q. I'm looking at -- it's footnote 106 on page 30. And this is a description by Mitchell and Netter of how to execute an event study?

A. Yes.

Q. Why did you cite to this source?

A. It's one of the most widely cited articles regarding the practical application of event studies. It's by former SEC staff. It's been cited, I think, a thousand times, maybe more, so it's a reputable source.

Q. This source says, "The execution of an event study is quite simple. It involves the identification of an event that causes investors to change their expectations about the value of a firm. The investigator compares a stock price movement contemporaneous with the event to the expected stock price movement if the event had not taken place. There are three basic steps in conducting an event study: (i) define the event window; (ii) calculate abnormal stock price performance around the event; and (iii) test for statistical significant of the abnormal stock price performance."

You agree that's -- that's how

you basically put together an event study?

A. Sure, yes.

Q. What is -- what is an event window?

A. It's the period of time that you're examining the price response to the event.

Q. And what does it mean to define the event window?

A. Determine how long of a period of time, how long the window is going to be that you want to study.

Q. And do you agree with Michelle and Netter that that step of defining the event window takes place first before calculating abnormal stock price performance around the event and testing for statistical significant?

A. Depends on the study, what you're trying to accomplish. I think it can sometimes be true that you do it before, but I mean, if you're just trying to figure out how long -- what is the full price reaction to a piece of news, you would look at the length of time it takes

for that to be fully impounded into the market price.

Q. What do you mean by that?

A. Looking at a period of time in which the price is still responding to information and trying to determine when that price response is complete.

Q. How do you look at -- how do you determine the period of time in which the price is still responding to information?

A. I mean, you could look at the direction of the movement, how persistent is it, how large is it, how relatively rare or statistically significant it is, it might weigh in your calculus.

You could -- mostly you got to look at the news and see what's been disclosed, how complex it is, whether there's evidence of investors having difficulty interpreting or having -- dealing with uncertainty regarding that disclosure.

We also look at the knock-on effects, the follow-on events that occur,

that may occur, just that there might be a sequence of disclosures that could further influence the price.

Q. In your event study, you performed in connection with your first report, you used one-day windows for each of the events you were measuring, correct?

A. Yes, that's my -- pretty much my standard of methodology for assessing cause and effect relationship on earnings related dates or for satisfying Cammer factor 5.

Importantly though, that one-day window choice does not mean that the price response is complete after one day. What I'm documenting is that the price response in those one-day intervals is consistent with the direction and substance of the -- what was disclosed on those days.

Q. Why is it important for you to document that price response in those one-day intervals is consistent with the direction and substance of what was disclosed on those days?

MR. WHITMAN: Objection to form.

A. I'm trying to analyze whether there is a cause and effect relationship between corporate disclosures and Apache's stock price. So it's -- that's how you do it. Look at what was disclosed and how the price responded, how did investors react to it in those one-day event windows, the price responses were consistent in my opinion with the information disclosed, but I don't have an opinion on whether those events in their price responses were complete by the end of one day. That's not part of my analysis.

Q. In responding to Ms. Allen's conclusion that there was no significant price -- stock price decline following the April 23, 2019 alleged disclosure, what methodology did you use to determine the proper event window?

A. I haven't determined the proper event window. I showed that she did not consider the fact that over the two-, three- and four-day windows, that these are

very large persistent, cumulatively returns. And so -- and as you see, it's actually very rare to see two-, three- and really rare to see four-consecutive declines, and that shows up because you see the statistical significant increased. That confidence level increases as you roll across those two-, three- and four-day windows.

All I'm saying, Ms. Allen did not consider that. It actually was very rare and added up to a very statistically significant return over that period. And so highlighting what I consider to be a failure and something she should have considered in assessing price effect.

Q. According to your own event study, there was no statistically significant decline on April 23rd alone, correct?

MR. WHITMAN: Objection to form.

A. Not at your conventional levels, you're right, on the first day. But then it was significant on the second

day and then got even more significant as you went over time, which I think is consistent with the way the information was disclosed and how it was appreciated and that investors felt that it was -- they needed more details in order to figure out what the true impact was.

So they were searching for more information that -- I think, and further analysis and there was analysts reports that were published throughout this period that commented on it and the deferment, that is, of gas production at Alpine High.

Q. On April 24th, the day after the pre-market press release disclosing the deferral, April 24th, there also was no statistically significant decline, right, even under your own model?

MR. WHITMAN: Objection to form.

A. It's 86 percent confidence level, so that's a return you'd expect to see about 14 percent of the time or less.

Q. Well, if not statistically significant to a 95 percent confidence

level, right?
A. That's correct.
Q. And the same is true with the third day, if you look at the third day after the pre-market announcement of the deferral on April 23rd, on the third day, there also was no statistically significant decline at the 95 percent level under even your own study?
A. Very, very close to the 95 percentile or confidence level and it is significant at the 90 percent confidence level, which is a standard that many economists consider to be a threshold that many economists consider to be statistically significant.
And the reference manual on science statistics, our regression analysis does say that that is seen as a measure of statistically significant.
Q. But it's -- even under your own study, it is not statistically significant to the 95 percent level on day three, correct?
MR. WHITMAN: Objection.

A. Technically not at the 95 percent level, but 94.62 percent confidence level.

Q. Right. Technically is what we're going for here, right? It's statistics, not 95 or above?

MR. WHITMAN: Objection to form.

A. It's math, yeah. Mathematically, it's not 95 percent, very close though, correct.

Q. If the test -- if you were designing a test that said I want to know which days are the 95 percent level or higher, this date would not be included?

MR. WHITMAN: Objection to form.

A. I would not include it. I would put in a footnote that it is 94.62 percent as the confidence level.

Q. And then on the fourth day, on the fourth day following this pre-market April 23rd disclosure, there's also no statistically significant drop at a 95 percent level?

A. That day is not significant at the 95 percent confidence level. The cumulative returns are though.

Q. Right. But I'm talking about the fourth day, it's at the 53 percent level, right?

A. That's right.

Q. And if we look at even the first two, the first two days combined, that they -- April 23rd and April 24th combined as one unit of measurement as opposed to looking at them in serial fashion, on April 23rd and April 24, 2019 combined, there was no statistically significant stock price drop in Apache's stock using your event study?

MR. WHITMAN: Objection to form.

A. Did you say 95 percent, I missed it?

Q. Yes.

A. You did, okay. It is not significant at the 95 percent level. It is significant at the 92.58 percent level.

Q. And if we -- if we look at

Ms. Allen's alternative event study, the same is true if you look at all three days combined, right? If you look at the first, second, third days of the window combined using Ms. Allen's alternative event study, there is no statistically significant stock price decline at the 95 percent level?

A. No, you're right. It gets as high as 94.33 percent on the three-day event window and then creeps over 95 percent on the four-day event window. Well, that answers your question.

Q. Have you ever used a four-day long event window in assessing price impact in an efficient market?

MR. WHITMAN: Objection to form.

A. I mean, I examined four-day returns before. It's just maybe not in a report setting like for class certification.

Q. So you've never given any opinion before to any court in which you used a four-day event window like this?

MR. WHITMAN: Objection to

form.

A. For market efficiency, I don't think so.

Q. Have you ever given a report before to a court where you used a three-day event window in assessing price impact in an efficient market?

A. Price impact.

Q. Or stock price reaction?

A. Okay. I might have. I can't recall. I've definitely done two-day returns on estimating damages, price inflation, and I think there's maybe a three-day in there somewhere.

Q. In the three-day you think might be in there somewhere, was that one like this where the days individually starting at day one and day two were not significant and adding that third day in made it significant or was that situation like you told me about earlier, where there's a -- there's an impact on day one and I'm going to look out now on day two to see does the market still impacting from the impact I saw on day one?

MR. WHITMAN: Objection to form.

A. I can't recall. I think it's usually that there's a sequence of events that -- over a period of time that -- and also continued reaction by analysts which in their own right could contribute to the price formation process, which is established in the academic literature.

Q. Have you ever, that you can recall, given a report that you used a two-day window where it's like this, where the market -- that the news was released for the first day so it was two full days of the news being on the market, not a post-market release the night before and looking at that second day?

Have you ever before given any report to a court where you've used a two-day window, where the first date was not significant, but by adding the first and second dates together, you found significance?

MR. WHITMAN: Objection to form.

A. I can't recall the specific confidence levels of, like I said, the two-day return windows and maybe three-day return windows that I've analyzed in the past. I want to say there's a -- the 90th percentile or I'm sorry, the 90 percent confidence level was either on the first or second day, I can't remember which one it was.

But again, it's more about the event being unconfounded, so it's -- you got a clean window with respect to estimating the full price response. And yeah, cumulatively, the returns can look -- can add up to be statistically significant at various confidence levels. I haven't opined on -- yeah, that's it.

Q. So you think you might have previously given an opinion to a court using a two-day window where there was a 90th percentile confidence level on the first or second date, but you can't think of any situations where you even used a only two-day window where there was no significant return at the 95 percent level

on the first day?

MR. WHITMAN: Objection to form.

A. I just can't recall right now the specifics of all the cases I've done in the past and what the confidence levels of the various returns were. So I probably should not even say there was a 90 percent one.

But I do know that there's this -- that other cases and courts have accepted models where there's been very long windows. The Household case comes to mind and, you know, the price responses are due to the information, the relevant truth leaking out, and the market appreciating it.

So all I'm describing in my reply report is that there actually is a pretty steep decline following the April 23rd announcement of gas deferrals, and Ms. Allen didn't consider it. And if she places undue weight on statistical significance, which I think she does, this might be something she'd want to consider,

but she did not.

Q. You're not even saying that the court should look at a four-day window here, right?

MR. WHITMAN: Objection.

A. I haven't analyzed loss causation and damages. So I know the plaintiffs plead a four-day response, so ideally, Ms. Allen should have looked at the four-day response, but she didn't.

Q. You're not in your reports or in your testimony recommending that the court use a four-day window here to analyze price reaction?

MR. WHITMAN: Objection to form.

A. Again, I've not been asked to analyze loss causation or damages and to estimate the price inflation dissipated as a result of the alleged corrective disclosures in this case. So if asked to do that, then I'll consider all that's been alleged, plaintiffs' theory of liability, and look at the economic evidence and come to a conclusion about what price inflation

was throughout the class period.

Q. You haven't been asked by plaintiffs in this case to give any opinion that would result in you giving the court any recommendation on how long an event window to look at following the April 23rd disclosure?

MR. WHITMAN: Objection to form.

A. Yeah, I don't think I have. I'm noting that during the window alleged to have caused losses to investors as a result of the disclosure of gas deference at Alpine High on April 23rd, there is a statistically significant company specific price reaction under both my model and Ms. Allen's model, but she just has ignored that.

And so if you're tasked with proving a lack of price impact, but you don't consider plaintiffs' theory of liability in full, I think it results in an incomplete analysis at best.

Q. Well, Ms. Allen did look at each of the four days after April 23rd,

including April 23rd, didn't she?
A. Individually, which is why I highlight that she didn't consider the multi-day reactions. She conveniently ignores the fact that the sequence of returns is very rare, very improbable to see this many negative company specific returns and as a result, it ends up being statistically significant.
Q. But only if you look at four days combined?
MR. WHITMAN: Objection to form.
A. No, you know, I wouldn't call -- I mean I can note empirically under my model, it's significant at the 90 percent level throughout for the two-, three- and four-day returns, and it's for the three- and four-day returns for Ms. Allen's model.
Again, I don't -- my opinion and I think a lot of court's opinion and statisticians' opinion is that it doesn't matter anyway, because this doesn't prove a lack of price impact even if it is insignificant. You cannot accept a null

hypothesis of no effect.

Q. What was the impact on Apache's stock price of the news released on April 23rd?

A. I haven't analyzed loss causation or damages. It's not within the scope of my opinions.

Q. You have no opinion on the impact on Apache's stock price of the news on April 23rd?

MR. WHITMAN: Objection to form.

A. I haven't -- discovery is still ongoing. I haven't been asked to analyze the loss causation or damages associated with this corrective disclosure.

Q. Did you analyze price impact?

A. I ended up analyzing price impact, I think, because in my reply to Ms. Allen's rebuttal, I noticed that there's a sequence of three statistically significant price increases in reaction to the announcement of the Alpine High play at being a world class resource that would drive shareholder growth and returns for

many years to come, even at low gas prices and the dry gas is pretty much free. So to me, that's strong evidence of front-end price impact to use the term front end.

Q. You did not analyze the price impact of the -- you did not analyze price impact in connection with the corrective disclosures during the focus period?

MR. WHITMAN: Objection to form.

A. No, because there's clear price impact when the corrective -- or I'm sorry, when the alleged misstatements were made, what Ms. Allen is doing here is a damage analysis or loss causation analysis trying to severe the link or the causal connection between the alleged corrective disclosures during her focus period and the alleged misstatements made throughout the class period.

Q. There's no allegation here that additional fraud related information was disclosed on April 24th, 25th or 26th, right?

A. I don't believe there's any

allegation that there's more affirmative disclosures by the firm were made during this period. I -- there is reaction by analysts and news media on these dates though. There's also no confounding information disclosed during this window.

Q. There's no confounding information at all disclosed on April 23rd, 24th, 25th or 26th?

A. I haven't found any and Ms. Allen hasn't identified any either, so that's based on the information set I have right now, that seems to be the case.

Q. Did you analyze price impact from the misrepresentations made during the focus period?

MR. WHITMAN: Objection to form.

A. I mean, I've -- in the reply report, I do document the statistically significant price increases in Apache's stock price following the announcement of the Alpine High play and the alleged misstatements related to it.

Q. My question is about the focus

period, so.

A. Sorry.

Q. So I'll ask it again. You did not analyze price impact with respect to the alleged misrepresentations during the focus period, correct?

MR. WHITMAN: Objection to form.

A. I mean, Ms. Allen points out, I think, that there's no significant price increases on those dates of alleged misrepresentations, which is consistent with plaintiffs' allegations and theory of liability since those were confirmatory statements that would not -- basically repeated prior misstatements related to Alpine High, that would not be expected to influence Apache's stock price on those dates. So that would be consistent with the allegation that price impact would have been maintained upon those misstatements.

Q. You don't contest Ms. Allen's point that looking at the misrepresentations during the focus period, we don't see any evidence of positive price

movement reacting to those alleged misrepresentations following those focus period misrepresentations?

MR. WHITMAN: Objection to form.

A. Sorry, I don't take issue with it?

Q. You don't contest?

A. Don't contest. No, as I just said, totally consistent with plaintiffs' theory of liability.

Q. And in your view, your understanding is plaintiffs' theory of liability is that the misrepresentations during the focus period served to maintain existing price inflation, but did not result in any new additional price inflation?

MR. WHITMAN: Objection to form.

A. That's my understanding as I sit here now today.

Q. But you have done nothing to test whether or not that's true?

A. I recall confirming that there

were no statistically significant price increases on those days. I think I confirmed it as well as I could, as an economist.

Q. Do you recall in Ms. Allen's surreply report, it's paragraphs 40 to 45 if that helps, that Ms. Allen concluded that if you used four-day event windows for the event study you performed in your initial report, only three of your 14 events days would have had a statistically significant price reaction?

A. Where is that again?

Q. Surreply report, which should be Exhibit 4, paragraphs -- starting at paragraph 44.

A. 44?

Q. I think I have that wrong. 40, starting at 40.

A. This is a silly analysis by Ms. Allen and I would never do this in a million years because if you're going to look at four-day event windows, you got to look at what happened over those four days. She has no idea what happened over those

four days so this could speak totally consistent with these returns with market efficiency and consistent with the value implications of the news conveyed over these four-day windows. We don't know because she didn't do it.

What I did was analyze one-day windows, which I always do. I told you why. It gives me a sense of how on the first day, the market reacts to this information. It does not reflect the full price reaction necessarily of the information disclosed on an earnings date, but it gives you a sense of the cause and effect associated with those disclosures.

Q. I understand that you may not think this analysis is relevant, but in terms of her conclusion that if you were to use four-day event windows for your original event study, only three of your 14 event days would have had a statistically significant price reaction, do you contest that conclusion in terms of the number of days that would have a price reaction that was significant if you used a four-day

window?

MR. WHITMAN: Objection to form.

A. No, I don't contest it right now, but that's not the point. The point is whatever happened in these four-day event windows needs to be appreciation, because what caused a stock decline on one day may have been for unrelated reasons caused a price increase in the sense that if you have a statistically insignificant or relatively unchanged price over a four-day event window, that can be perfectly consistent with market efficiency depending on the information flow during that period, which she did not analyze.

Q. You agree that in an efficient market, the market only reacts to information that is not already known by the market?

A. It's -- yes, but you got to be very careful about how people define by what is already known by the market. Because I know some people that use that term very loosely or strictly depending on

how you look at it. So it's something that needs to be considered for sure when assessing whether a stock price changes due to the disclosure of information is whether that information is understood and already priced in or not.

Q. A company's stock trades in an efficient market, that company's stock price at any given time already incorporates all previously known information, right?

A. Yes, I mean, in a semi-strong form efficient market, the stock price will reflect all publicly available information. That is a theoretical construct. What I've established is that there's a cause and effect relationship and all the other Cammer and Krogman factors support a finding market of general market efficiency, which means that most corporate disclosures are understood and received and imbedded into the price.

Q. And how long does it take in a semi-strong efficient market most corporate disclosures to be understood and received

and embedded into the price?

MR. WHITMAN: Objection to form.

A. Described in my report, it's context specific, depends on how the information was disclosed by who, the complexity of the information, whether it's refuted or not. So it's an empirical endeavor to determine how long it takes for prices to respond to information, even in a generally efficient market.

Q. What is it about the April 23rd disclosure in particular that you believe made it take so long for the market to react?

MR. WHITMAN: Objection to form.

A. I don't have an opinion on the length of time it took for the market to react to this disclosure. I've not analyzed loss causation and damages. What I can say though is that this is a deferment of gas production by Alpine High, which had previously informed the market that their gas production capabilities

would be or operations, excuse me, would be highly economic, profitable, et cetera, even at very low gas prices.

Some of the statements were that you're effectively getting the gas for free. That would really hum at prices below $2. Those types of statements which implies a situation where even though gas prices may be very low, and here they were negative for the end of March and early April due to capacity transport problems in the permeate, that was rectified shortly thereafter.

But when the -- when they deferred the gas, it signalled to investors that well, even though gas prices are lower, we thought they could produce at low prices, even very low prices. Well, apparently not, so that's now a contradiction that investors have to grapple with. And they're not sure whether it's going to come back online or not and when. So there's uncertainty embedded in this that I think is reflected in some of the analyst reports. That may have

contributed to a delayed reaction.

Q. But you're not opining that it did take the market more than one day to understand and appreciate the impact of April 23rd deferral announcement?

A. Well, only cause I haven't been asked to thoroughly analyze damages associated with this corrective event, but I do in my reply report, and Ms. Allen's report, looking at the same analysts reports, it seems pretty clear that this was described to be a negative event, not wholly unexpected given what prices were, but for Apache, again, if the expectation is that you're going to be profitable at even a very close to zero prices in your gas production operations, this is a negative, you know, somewhat expected event.

I mean, prices are low, so deferments are on the table always, but the fact that Apache did it, I think is with the prior statements is what is a little confusing to the market and there was analysts describing how they needed more

detail and more clarity and they were searching -- would be searching for it on the next conference call.

Analysts cut their production estimates in response as well. I just document this is in the reply report and the sequence of events, I mean, there's still discussion of it during the four-day window, which does provide evidence that investors were still grappling with the ramifications of the deferment over this time period and it continued to decline is the other point to the tune of it being approximately eight percent overall decline net of market industry effects.

Q. Based on all of the information you've looked at, both about the alleged misrepresentations and this disclosure, including the analysts reports you're talking about and news articles in the days that followed the April 23rd announcement, can you explain why it would take the market four days to appreciate the impact of an announcement that Apache was deferring production?

MR. WHITMAN: Objection to form.

A. Sorry, can you please repeat the question.

Q. I guess let's start here, what is the misrepresentation that this disclosure is correcting in your understanding?

MR. WHITMAN: Objection to form.

A. Based on my understanding of the Complaint as upheld by the court here, I understand plaintiffs to be alleging that this is corrective of misstatements regarding the profitability of Alpine High at very low, if not zero, commodity prices or virtually zero I think is the language.

Q. And if before the market opened on April 23rd, analysts already knew what the commodity prices were, and if before the market opened on April 23rd, the market was told by Apache in a press release that Apache would be deferring production, why would it take four days for the market to appreciate that that announcement was

corrective of what you say was a misrepresentation that Alpine High would be profitable at very low commodity prices?

MR. WHITMAN: Objection to form.

A. I -- I got to admit, I didn't follow that completely. I'm sorry. Why did it take four days, is that effectively the question?

Q. Yeah.

A. So prices were low during this period for sure, even negative in late March, early April, that is a transitory market event caused by pipeline capacity constraints in the permeate, which was rectified and prices went above zero shortly thereafter.

Not every -- I mean, it's -- the industry did not stop producing gas during this period. Apache did. They deferred gas production and they never turned it back on until after the class period. They contradicted their prior statements regarding effectively the break even cost at which they could profit, which

was very low, if not, close to zero as they conveyed to the market.

So a deferment, a definite deferment implies that's no longer -- that's not true and it's a negative event and analysts comment about the fact that Apache needs to go into greater detail of how the deferrals will affect its production plants for the rest of 2019.

Yeah, other analysts felt that incremental details were needed to fully quantify the impact of the deferral, and that I think is evidence of uncertainty which as I've described in my report can contribute to longer price reaction times for the full price impact to be felt. And here, we do have relatively or economically and in some cases significantly significant price declines over the course of the two, three, and four days following this announcement.

I don't think that it's inconsistent. I think that is inconsistent with the notion which is not conveyed in the analysts reports that this was fully

expected, the deferment that is.

Q. And it's not significant over the course of two days, 95 percent level, right?

MR. WHITMAN: Objection to form.

A. Not at the 95 percent level. Under the 90 percent level in my model, it is, that seems pretty significant.

Q. And the additional details that you say you've seen evidence of analysts seeking no additional details were provided in the first four days, right?

MR. WHITMAN: Objection to form.

A. Right. So left the uncertainty dangling. So the possibility is that it contributed to a prolonged reaction time.

Q. What did the market understand on days three and four following this disclosure, that it did not understand on days one and two, if anything?

MR. WHITMAN: Objection to form.

A. I'm just looking for the

analysts reports. There's a Cowen report on April 26th, and a Barclays report shortly after on April 28th.

Q. What paragraph are you at? Sorry.

A. Paragraph 25.

Q. You're talking about the Cowen one on the 26th, that's the fourth day we're talking about here in the window?

A. Yeah. So it's an analyst reducing its estimates of total production for Apache in response to this disclosure. Barclays does it a few days later, but I think this is evidence of the fact that the investors and analysts were still grappling with this disclosure and its impact over the period of time here.

Q. But is there anything in particular that you've seen that the market understood on days three and four, that it did not understand on day one?

MR. WHITMAN: Objection to form.

A. I think just their expectations. Cowen's at least they

updated their model on April 26th, which is the last day. They're undoubtedly not the only one that had, you know, in the universe of investors across the market, but might have formulated their thoughts in response to this deferment during the four-day window. So I'm thinking this is evidence of the possibility that there's -- the uncertainty is creating a prolonged price reaction but it's -- there's only one corporate announcement, it's the deferment on April 23rd.

Q. Cowen updated their model, you believe, on April 26th. That was not in reaction to any new information from Apache after April 23rd, right?

A. Yeah. I mean, they describe the compelled shut-ins at Alpine High and then they reduced the total production estimate for 2019.

Q. And the compelled shut-ins at Alpine High were announced before the market opened on April 23rd?

A. Right.

MR. WHITMAN: Objection to

form.

Q. Do you agree that not all negative information is corrective?

A. Of course. It's -- you know, corrective information is corrective of an alleged fraud or misrepresentations, so you can have company specific information disclosed that's unrelated to those allegations, so yeah. Yes.

Q. If negative information doesn't change the market's expectations about the alleged misrepresentation, it's not corrective?

MR. WHITMAN: Objection to form.

A. Please repeat it, sorry.

Q. If negative information doesn't change the market's expectations about an alleged misrepresentation, then that negative information is not corrective?

MR. WHITMAN: Objection to form.

A. I don't quite follow what changing your expectations to an alleged misrepresentation means.

Q. If negative information doesn't change the market's expectations -- in this case, if negative information doesn't change the market's expectations about the profitability of Alpine High at low commodity prices, then it would not be corrective of the alleged misrepresentations concerning the profitability of Alpine High at low commodity prices?

MR. WHITMAN: Objection to form.

A. I think -- you're asking whether it's corrective, right. Corrective -- whether it's corrective or not is not for me or Ms. Allen. It's the trier of fact will determine whether something is corrective or not.

Q. So you are giving no opinion on this case, this case of whether or not any of the alleged corrective disclosures is corrective of any of the alleged misrepresentations?

MR. WHITMAN: Objection to form. Misstates testimony.

A. I as always assume plaintiffs' theory of liability at whatever phase of the case we're in, sometimes it changes over the course of the merits phase, but I assume that plaintiffs' operative theory of liability is true. I have no basis for any other opinion on liability.

Under those -- that assumption, I estimate damages based on the alleged corrective disclosures and their influence on the price.

Q. Do you agree that if the market expects the negative event to occur, then when the occurrence of that event is announced, a stock trading in an efficient market would not be expected to respond or react?

MR. WHITMAN: Objection to form. Incomplete.

A. I mean you're basically asking me to assume that it's not new information in an efficient market, only new information causes price changes. Yes, that's true in a vacuum. Practically, it depends a little -- a lot on how well

publicized information is and what's appreciated by investors, but it's kind of context specific and you have to be very careful with respect to what's new or not is my experience.

Q. How do you determine what's new or not?

A. Looking at the historical record, what's alleged to be new information disclosed previously, if that's objectively true, then it shouldn't influence the stock price. However, if it's -- sometimes, I hear the argument that oh, it covers the same risk. It's the same general risk and they already discussed their risk in a 10-K, so when they discuss the precise outcomes of risky behavior that caused the stock price to tank, well, it's old news. It couldn't have caused the price decline even though it went down 20 percent.

So that is an example of a case where I think what's purported be stale information shouldn't influence the stock prices, not true. It's actually a

revelation of new information that causes the stock price to react.

But yeah, you can usually tell by looking at the flow of news and information over time and the ease of accessibility of certain pieces of information, because sometimes I've encountered cases and seen court opinions where maybe some piece of information was publicly available in a very hard to find spot on the internet, might even be a pay wall or restricted database. That may not be fully reflective in the stock price so you might see that the disclosure or the broader publication of that information influenced the price when it's publicized.

Q. Do you agree that no analyst lowered its price target for Apache in response to the April 23, 2019 alleged corrective disclosure?

A. I can't remember right now whether that's true or not. It may be.

Q. You don't claim anywhere in either of your reports that any analyst lowered its price target for Apache in

response to the April 23, 2019 alleged corrective disclosure, right?
A. I do not.
Q. And no analyst changed their evaluation of Apache in response to the April 23, 2019 alleged corrective disclosure, right?
MR. WHITMAN: Objection to form.
A. Well, I chronicle a bunch of analysts that changed their estimates of production in response to this announcement.
Q. Well, I'm asking about changing their valuation, no analyst disclosed a changed valuation of Apache in response to the April 23, 2019 alleged corrective disclosure?
A. I thought I heard evaluation, but you're right. A valuation or price target change, I don't recall any occurring. I don't remember putting any discussion of that in my reply report.
Q. And no analyst changed their views of the mix of oil and wet gas versus

dry gas of Alpine High's reserves in response to the April 23, 2019 alleged corrective disclosure, right?

MR. WHITMAN: Objection to form.

A. Yeah. And I don't know why they would given that was not a piece of information disclosed by the company, the reserve mix.

Q. And by the same token, no analyst changed their views of the quantity of Alpine High's reserves in response to the April 23, 2019 alleged corrective disclosure, right?

MR. WHITMAN: Objection to form.

A. I don't believe so. This was again about production of gas.

MR. WHITMAN: John, when you hit a good point, if we could take another five-minute break.

MR. LAWRENCE: Yes, this works.

MR. WHITMAN: Does it work now? Okay, great.

MR. LAWRENCE: Yeah.

THE VIDEOGRAPHER: The time is 11:11 a.m. We're going off the record.

(Whereupon, at this time, a short break was taken.)

THE VIDEOGRAPHER: The time is 11:23 a.m. and we're back on the record.

BY MR. LAWRENCE:

Q. Dr. Nye, what is your understanding under plaintiffs' theory of what the market was reacting to on October 25th, when the announcement of Mr. Keenan's resignation was disclosed?

A. The market was reacting that Mr. Keenan's resignation for sure.

Q. And how was that corrective of the alleged misrepresentations?

MR. WHITMAN: Objection to form.

A. My understanding is that it's corrective of plaintiffs' allegations that Alpine High was world class and immense resource that would drive shareholder growth and returns for many many years to

come and was a transformational investment.

Q. And what new information contradicting those alleged misrepresentations was disclosed or uncovered on October 25th?

MR. WHITMAN: Objection to form.

A. Mr. Keenan resigned. He was the head of the San Antonio office and worldwide exploration and in charge of Alpine High is my understanding and responsible for turning it around and making it a -- not turning it around, developing it into a transformational, highly profitable, and compelling resource that would drive growth and returns for years to come.

At this point, the company has -- the Alpine High has deteriorated in the market size and in reality, very much. You know, few months, six months after the deferral of gas at Alpine High and there's promises of turning it around, the second half is going to be better.

And then Mr. Keenan's

resignation implies that that's at least less likely to be true, if not almost certainly, there will be no recovery and it's an incrementally negative step in the ability of the company to generate positive cash flow from Alpine High.

Q. Why does Mr. Keenan's resignation imply that that's less likely to be true?

A. Tauted as the godfather of Alpine High. He got the president's award for this transformational resource and was tauted as being key to, you know, value creation and at the firm and especially at Alpine High. So losing him was obviously -- I mean, market reacted negatively. They said it was a negative event. It declined significantly, the price that is.

And met -- all the analysts noted the poor performance at Alpine High and that it likely contributed to the decision to resign or some speculated that he was terminated.

Q. Was the October 25th disclosure of Mr. Keenan's resignation corrective in

any way of the alleged misrepresentations concerning the mix of oil and wet gas versus dry gas?

MR. WHITMAN: Objection to form.

A. You know, again, what's corrective or not, I'm not the trier of fact. But I think plaintiffs are alleging that his resignation was prompted by the poor results that Alpine High, which included albeit earlier in the class period, disclosures related to the mix being gassier than previously disclosed.

So I would think that this resignation, under plaintiffs' theory would be, at least partially, the result of that I guess mistake if -- but as alleged, it's a fraud.

Q. That disclosure you're talking about occurred before the focus period, right?

A. There's one credit of disclosure in my mind where there was a disclosure related to the mix of oil and gas and it's I think February 22, 2018, so

that's the day before the so-called focus period.

Q. There are no corrective disclosures during the focus period related to the mix of oil and wet gas versus dry gas at Alpine High, right?

MR. WHITMAN: Objection to form.

A. Like I just said, I think the Keenan resignation was, as alleged at least, the product of the full fraud or misconduct that was missed and this state of affairs at Alpine High, including the mix of gas and oil that was misrepresented to the market.

Q. The state of affairs at Alpine High, nothing new about the state of affairs of Alpine High was disclosed on October 25th other than Mr. Keenan's resignation, right?

A. Right.

Q. No analyst changed their estimates of the mix of oil and wet gas versus dry gas or of Alpine High's reserves in response to the April 23, 20 -- sorry,

to the October 25, 2019 disclosure?

MR. WHITMAN: Objection to form.

A. That's what Ms. Allen says, and I don't recall any evidence to dispute that. I think there's actually in her chart a slight downtick, but not a big one.

Q. Not -- not immediately following this disclosure, right?

A. I could look it up. Let me find it. Hold on. It appears to be -- this is just one. This is Credit Suisse or "Suisse," however you say it, it's relatively stable throughout the period of the estimates of reserves.

Q. There's no analyst report or news article on October 25th attributing the stock price decline to any news about Alpine High, right?

MR. WHITMAN: Objection to form.

A. The way I read it, it is about Alpine High. It's Mr. Keenan, he's the godfather of Aline High. He won the president's award for his heroic

contributions to the discovery and development of what was the transformational Alpine High plague for Apache.

Q. The -- what I'm asking you is the analyst reports and news articles on that date, none of them attribute the stock price decline itself to anything about Alpine High, right?

MR. WHITMAN: Objection to form.

A. Well, I think they do because the leader and -- of Alpine High just resigned.

Q. Other than the fact that the leader of Alpine High has just resigned, there was no information about Alpine High disclosed on that date?

MR. WHITMAN: Objection to form.

A. There was discussion of its poor performance, but yeah, the big news was Steve Keenan resigning.

Q. Well, the discussion of its poor performance, of Alpine High's poor

performance was all discussion of news that had previously been disclosed and discussed by those same analysts, right?

MR. WHITMAN: Objection to form.

A. Yeah, but connecting it to the resignation, I think, is new.

Q. The resignation itself was new?

A. Sure, yeah.

Q. But the performance, everything that was discussed on October 25th about Alpine High's performance was something that was previously publicly discussed before October 25th?

MR. WHITMAN: Objection to form.

A. I think so, the actual performance of Alpine High. I don't believe any new performance metrics or measures were disclosed on that date.

Q. Plaintiffs are not claiming in this case that negative information about Suriname is corrective of any of the alleged misrepresentations, right?

A. No. The misrepresentation

concern Alpine High.

Q. You note in your report that Apache's stock price reacted to news of Keenan's resignation within an hour of -- of that resignation being disclosed; do you recall that?

A. I mean, I describe the evolution of the information set and the intraday price over the course of October 25, 2019.

Q. Yeah. You say at paragraph 37, "Apache's stock price plummeted immediately after Mr. Keenan's departure was announced at 9:44 a.m., but then partially rebounded roughly 35 minutes later after RBC Capital Markets reported at 10:19 a.m.," what they reported.

Apache's stock price plummeted in reaction to Mr. Keenan's announcement in under 35 minutes?

A. Yeah. You can see it right there on the chart.

Q. Yeah. Can you explain, earlier you talked about what factors can impact how quickly the market understands or -- or

prices and new information.

Can you explain how this 9:44 a.m. release about Mr. Keenan's resignation differs from Apache's press release on April 23rd, such that the October 25th announcement would be understood and priced in in less than an hour and the April 23rd would take four days?

MR. WHITMAN: Objection to form.

A. It is a matter of observation. You can see what's going on here. With respect to April 23rd, plaintiffs have alleged a four-day window. I can see that's a significant decline over those four days, even three days, and et cetera.

Here you can see a much more sudden reaction. It also is a very final decision. It is he's gone. This is a godfather of Alpine High in charge of developing this thing into becoming cash flow positive for generations to come. Well, not going to happen when he resigns. So I think that is a much more final decision than deferments of gas, which may

or may not hurt 2019 production and maybe require costly repairs, because if you shut it down for too long, it doesn't just turn right back on, the gas production.

Yeah, I think that might explain it. I haven't done a loss causation or damages analysis, but here I can see objectively, there's strong evidence of price impact associated with the disclosure of Mr. Keenan's resignation in the sense that it caused the stock price to decline, that's evident from the price chart and analysts reports and the news.

Q. Is there equally strong evidence of price impact during for that four-day window after April 23rd?

MR. WHITMAN: Objection to form.

A. It's a different event. It's got obviously a longer window. It is a rare occurrence to see those -- that many significant declines and there's analysts reports and news during that window, so that suggests that it was a fairly uncertain and complex disclosure that --

and more was needed to understand its implications with respect to 2019 production. And I'm speaking obviously with respect to April 23rd and that four-day window.

Here, I don't have an opinion that this is the -- in October 25th of 2019, I don't have an opinion that the price response is complete, right. I'm noting something that Ms. Allen omitted from her price impact analysis, which appears to show a strong price response to Mr. Keenan's resignation and as we'll talk about, I'm sure in a little bit, once it was cleared up that Suriname had nothing to do with his resignation, the price recovers a little bit and then stabilizes.

And what that means is that the market by the end of the day already knew that Suriname had nothing to do with the resignation and they weren't even in a position to report any results from the Maka-1 formation in Suriname. So the close decline here from October 24th to October 25th reflects Mr. Keenan's

resignation and controlling for any possibility that Suriname influenced the decline over that day window.

Q. Don't the analysts reports and news stories on this day actually attribute the price of decline to Suriname despite the statement by the company that -- that the Suriname results were not yet ready?

MR. WHITMAN: Objection to form.

A. No. No, they do not. It just -- read the reports. What they describe clearly is what I just conveyed here with the intraday price chart, shown the intraday price chart.

Initially, there was in the morning some concern about it being related to Suriname. The company talks to RBC. They say it has nothing to do with Suriname and we're not in a position to report any reports. We don't have even results with respect to Suriname. So even -- we don't even know if it's got problems yet or not. So that puts to rest all Suriname related concerns. The company reiterates that in a

press release on -- at 11:21 a.m.
At that point, it's very flat, just hovers around $22. And all of those analyst reports say the company has reported that it -- the resignation had nothing to do with Suriname. It was unrelated. They also say stuff like in our opinion, we think it has nothing to do with Suriname.
Q. You've described the -- in talking about April 23rd just now, you described the price declines for four consecutive days as being a rare occurrence; what do you mean by that?
A. I've said it, I think, two or three times today.
Q. Okay.
A. When you have a sequence, most of the times you have stock prices that you could see it bounce up and down. So you're -- it's improbable to see back-to-back even price declines or price increases. It gets even less probable to see three days of consecutive declines. It's even more improbable to see four days of consecutive

declines. And that's what causes the cumulative returns to become more and more statistically significant in the sense that they're confidence level is increasing.

Q. Have you studied how often a public company in general or Apache has two-day declines, three-day declines, four-day declines, five-day declines, or is this just your supposition?

MR. WHITMAN: Objection to form.

A. I wrote my dissertation on volatility estimation. I've performed, I don't know, a thousand plus event studies over my ten-year career as an expert witness, or research and so I think I do, yes, I think that's based on my experience conducting these event studies.

Q. What percent of the time does a company like Apache have a four consecutive day decline?

MR. WHITMAN: Objection to form.

A. It's an empirical issue. You could just look at it. I could take a

spreadsheet and tell you.

Q. You're telling me it's rare. Do you know how rare it is?

A. It's easily discernible. I have a series of price changes, net of market industry effects of Apache during the control period. I could tell it to you in a few minutes.

Q. You haven't done that work yet and you're telling --

A. Well, I have --

MR. WHITMAN: Just let him finish, right, before you start arguing with him.

A. So I have because the exercise here tells me how rare that sequence of returns is, how rare that four-day decline is, because we're capturing the volatility in the regression analysis. So you -- variances are additive and so you take the square root out of the added variances, you now got the measure of the volatility over a four-day return.

So as a matter of, you know, evidence, you know, it perks, I can tell

you that the results reliably and scientifically imply and state that this is a very rare occurrence.

Q. Do you have any sense of what percent of the time it's the case for Apache sitting here right now?

MR. WHITMAN: Objection to form.

A. I can -- I mean I have the teased -- the confidence level, where is this report number three, yes.

Q. What are you looking at now?

A. I'm looking at page 21 of my reply report and I'm going back to that table with the four-day event window returns. And based on my regression model, it is estimating based on the control period, the hard data that I've used to estimate my regression model, that a -- the four-day decline of 7.17 percent, net of market and industry effects, is only expected to occur less than one percent of the time.

Q. Now, you're giving me the specific return that it's -- it's rare for

-- I'm just asking you, I mean, it makes sense to me that the four-day return at a specific level will be -- won't be repeated very often?

A. No, it's not a one -- it's a based on all of the data, all of the returns, that's the -- you'd expect a return as negative, I guess, as an absolute magnitude as big 7.17 percent to occur less than one percent of the time. So it's 7.17 percent and more negative.

Q. The less one percent is like three times a year?

A. Yes.

MR. WHITMAN: Objection to form.

A. I'd have to do the math, but I'll take your word for it. That seems rare.

Q. And that's just at the 7.17 percent greater level, right?

A. Yeah, but the exercises I think you wanted me to do, now that I'm appreciating it, is I would just look at the number of signed reactions. I just

would say it's positive, negative, positive and look at how many times there's a four-day decline in the sample. It's easy to do.

Q. Talk about the March 16, 2020 Seeking Alpha report. In your reply report, which is Exhibit 3, page 44.

A. I'm there.

Q. Great. You say at paragraph -- at paragraph 44, on March 16, 2020, prior to market open, Seeking Alpha issued a report on Apache, "revealing that in the wake of an oil price crash, enormous spending and lack of production from Alpine High, Apache was particularly challenged among its E&P peers," right?

A. I do. That's what's alleged, yes.

Q. And that quote you have there, that's the quote from the Complaint, that's not a quote from a Seeking Alpha report, right?

A. Right.

Q. That's plaintiffs' characterization of what they see in the

Seeking Alpha report, not necessarily what
the Seeking Alpha report actually says?

MR. WHITMAN: Objection to
form.

A. I mean I've read the Seeking
Alpha report. It's a pretty good summary
of the Seeking Alpha report but yes, I
guess that's the words in the Complaint
from plaintiff's counsel or plaintiff.

Q. You then go on to say, "The
Seeking Alpha article noted that the
Company had 'shifted away" -- "shifted
capital away from the wet-gas rich Alpine
High play which has been driving the
company's production growth,' and that
'Apache also reduced Alpine High's value by
$1.4 billion.' The analyst calculated that
Apache's 'lofty debt-to-equity ratio' was
'the highest among all large-cap
independent oil producers.'"

And there's a block quote below
that, expounding on the debt-equity issue,
right?

A. Yes.

Q. So the Seeking Alpha report is

several pages long. Are these quotes that these reflect the information in the Seeking Alpha report that you understand plaintiffs claim in this case were corrective of any of the alleged misrepresentations?

MR. WHITMAN: Objection to form.

A. They are -- yeah, it's my attempt to summarize the allegations in the Complaint and drawing on the Seeking Alpha report itself, but I think plaintiffs are alleging that the report is corrective and it's ultimately the opinion of the analyst who wrote the Seeking Alpha report that they're concerned about Apache's financial flexibility and given the current market conditions and the fact that it has -- that Alpine High had required a lot of capital outlay and cost, but almost very little return.

Q. The fact that Apache had "shifted capital away from the wet-gas rich Alpine High play, which has been driving the Company's production growth," that

information was known well before the Seeking Alpha report, right?

MR. WHITMAN: Objection to form.

A. Yes. I mean, the company's restructuring effectively had been underway.

Q. It wasn't breaking news about Apache shifting capital; the shifting capital was previously announced, right?

A. Yes, I believe so.

Q. And similarly, the fact that Apache had also reduced Alpine High's value by $1.4 billion, that was something that Apache had announced weeks earlier, right?

A. The impairment charge, yes.

Q. And Apache's debt-to-equity ratio, this analyst isn't using anything to determine that it wasn't anything that was publicly known well before this Seeking Alpha post, right?

MR. WHITMAN: Objection to form.

A. My recollection is that the analyst is noting the year-end 2019

debt-to-equity ratio, but the -- ultimately the conclusion here is that given all these factors, Apache is in a very precarious position and not and unable in this investor analyst's opinion to whether what could be a rather difficult period given where commodity prices were and how things were shaping up to be in the near future.

Q. So is the new information in here, in your view, the fact that this analyst reached a conclusion that given all these factors, Apache was in a precarious position?

A. And that it was particularly challenged amongst its peers, which also prompted Susquehanna to update its projected net debt to EBITDA ratios for the company and downgrade the stock and reduce the price target.

Q. So other than the fact that the -- talking about the Seeking Alpha report itself, other than the fact that the Seeking Alpha analyst reached the conclusion that given the previously disclosed factors he mentions, Apache was

in a very precarious position and the fact that Apache was challenged as a result of those conditions in comparison to its peers, is there any other information in the Seeking Alpha report that you believe is new to the market?

MR. WHITMAN: Objection to form.

Q. Relevant to Alpine High or Apache?

A. This particular investor's or analyst from Seeking Alpha's clearly looking at all the data present at that point in time and coming to a conclusion regarding the precarious financial status and debt load and ability to generate cash flow in the near future for Apache and -- and basically coming to the conclusion that Alpine High had hampered it so much that it was now in a dangerous spot relative to its peers, which didn't have a similar Alpine High in their portfolio of investments or assets.

A very similar conclusion was reached by Susquehanna on the same day, so

its investors clearly reassessing their projections with respect to net debt and financial balance sheet flexibility for Apache on this date.

Q. I still want to stay -- we'll get to Susquehanna. I think it will be easier if we do one then the other. You can tell me about both.

But as to Seeking Alpha, I think what you're telling me is the new information there is that this investor who was making the post on Seeking Alpha had himself reached the conclusion about the company's previously disclosed shift away from the Alpine High play and the company's previously disclosed reduction in Alpine High value and the company's previously disclosed debt and equity levels and that that conclusion that this analyst reached about those previously disclosed issues is what the new information is; is that right?

MR. WHITMAN: Objection to form.

A. That is the new information to the market at that point in time. Yeah,

that does convey that Apache as plaintiffs alleged was particularly challenged with respect to balance sheet flexibility and the ability to borrow and survive the oil and commodity price shocks that were occurring at the time.

Q. Does the Seeking Alpha analyst say why he believes that Apache was particularly challenged with respect to balance sheet flexibility and the ability to borrow and survive the oil and commodity price shocks?

A. A lot of it is devoted to Alpine High.

Q. And those reasons are all reasons related to Alpine High or other issues that Apache that were previously known, right?

MR. WHITMAN: Objection to form.

A. Previously known, but in the current context, much more serious given where at this point in time, oil and commodity prices were heading. So it's a precarious situation created by the

company's disasters for at Alpine High, I think is the new information.

Q. So you don't think that -- you don't -- you don't think that the market already understood the impact of Alpine High on Apache's balance sheet and its debt levels and its ability to use additional borrowings?

MR. WHITMAN: Objection to form.

A. They were aware of it, but when you start seeing the products you're selling tank in terms of price and then you're in a -- now in a worse situation because you don't -- you have a lot of debt that you incurred as a result of Alpine High, which didn't pay off at all, and allegedly was a fraud, so now you've got a situation where this is much worse than if they hadn't had Alpine High in its disastrous implications to the company's balance sheet.

Q. Is there any allegation that Apache didn't disclose that the market wasn't aware of the impact of the Alpine

High play on Apache's overall financial health?

MR. WHITMAN: Objection to form.

A. I mean the -- I know you don't want to talk about it, the Susquehanna report does talk about that and saying that even though they've cut the dividend and taken the impairment charge, further cuts may be necessary and they're particularly worried, so that's new information from that analyst, which as a result increases the projected net debt to EBITDA ratios, which is a measure of the company's ability to pay off its debt.

Q. So which misrepresentations -- I think we've talked about three basic categories of misrepresentations here, right, all Alpine High related; one is the dry-wet oil gas mix; one is overall volume of reserves; and one is Alpine High's ability to be profitable at lower commodity prices. Which one, two or three of those categories of misrepresentation does the Seeking Alpha report information correct?

MR. WHITMAN: Objection to form. Incomplete as to the categories of alleged misstatements.

A. I think what I described earlier was also the misstatements related to this being transformational discovery, world class, immense resource play that would drive shareholders returns for many, many years, return cash flow hand over fist for generations to come, or decades to come.

Q. Feel free to use that one, too. Explain to me which misrepresentations --

A. That one.

Q. -- you believe exist in plaintiffs' claim the Seeking Alpha report is corrective of?

A. My understanding is that this Seeking Alpha report is corrective of that fourth category that I just described where the company would be transformational and have drive shareholder value and growth for many, many years.

Q. And what about this disclosure do you understand corrected that alleged

misrepresentation?

MR. WHITMAN: Objection to form.

A. It's describing a more severe exposure to hear a market downturn because of Alpine High and the leverage it thrust upon the company's balance sheet which put it at a precarious position relative to its E&P peers, most of which were not downgraded by Susquehanna on this day.

Q. A couple of times we talked about the Seeking Alpha report you've called the author the investor. Do you know who the author of the Seeking Alpha report is?

MR. WHITMAN: Objection to form.

Q. Or his background?

A. I think I looked at it at one point. I can't recall right now. I've also said analysts. It's obviously someone who's analyzing and valuing, trying to come with valuation and recommendation for Apache stock.

Q. Do you know what the

requirements are at Seeking Alpha for somebody to be allowed to post a report like this?

A. I can't recall off the top of my head. I know we had discussed that to some extent in the reply reports and Ms. Allen's opening report. Maybe she did.

Q. Do you know whether the author of this post has any sort of financial investment background or training?

MR. WHITMAN: Objection to form.

A. I'm just reading Ms. Allen's description of Mr. Khan, the author, and yeah, I think I saw that he had a few other articles that he had published online at least, but that's as far as I know.

Seeking Alpha though is a source of -- or can be a source of material new information because it is -- it's highly publicized, easy to access and oftentimes is correlated with price declines, at least when the new articles come out on Seeking Alpha.

Q. All right. Let's talk about

the Susquehanna report now, which is the next paragraph of your -- of your reply report, paragraph 45.

I guess explain to me what it is in the Susquehanna report that you understand, according to plaintiffs' claim was corrective of a prior misrepresentation?

MR. WHITMAN: Objection to form.

A. My understanding is that Susquehanna is coming to a conclusion that's consistent with the Seeking Alpha report in that Apache is in a relatively precarious financial position in its industry and that ultimately, I guess, it would be related to the misstatements concerning the Alpine High play being world class and able to generate significant shareholder returns and growth for years to come and decades and decades.

Q. Is there any new information about Alpine High or new information about Apache's financial health or resources disclosed in the Susquehanna report?

MR. WHITMAN: Objection to form.

A. The Susquehanna report is noting that further cuts in addition to the dividend cut and the impairment charge may be necessary for Apache, and that given the current market conditions, they expect there to be increased net debt to EBITDA ratios, which again is reflective of the company's ability to pay off its debt, and as that ratio gets higher, it's, you know, riskier and riskier, because there's relatively more debt compared to the amount of EBITDA to pay it off.

So in that sense, they're definitely talking about Apache's financial health and what they expected and they expected it to get worse in the near term.

Q. So is the -- and is that what you think is the new information in the Susquehanna report, what you just described to me?

A. Yeah. As I described in my report, paragraph 47, the new news is the downgraded investment recommendation, the

reduced price target, and the revised net debt to EBITDA ratio projections, and also the fact that many of the -- most of the exploration and production companies that were examining this report were not downgraded or had their price targets reduced.

Q. Several were, right?

A. Three, I think, and I think, I might have that number off, but it's not -- it's certainly minority. And they comment on, you know, the fact that Apache is -- additional cutbacks may be necessary. And plaintiffs' theory of liability is that's because of the disastrous implications and ramifications of the Alpine High investment.

Q. So what misrepresentations is the Susquehanna report corrective of?

MR. WHITMAN: Objection to form.

A. I think I answered this, but maybe not. Similar to Seeking Alpha, this is related, corrective or not again, I'm not 100 percent sure whether -- I don't

think I'm supposed to have an opinion on what's corrective. I think plaintiffs are alleging that it's related to or corrective of the misstatements related to the company's ability to generate positive returns and growth for many years to come and that the Alpine High play is world class, immense and transformational.

Q. And just to close the loop on that answer, does the Susquehanna report or the Seeking Alpha post in your understanding correct any of the other categories of alleged misrepresentation related to the mix of wet and dry oil and gas or the volumes of reserves, or the ability for Alpine High to be profitable at low economic levels?

MR. WHITMAN: Objection to form.

A. I'm hesitant to answer that. And I will, but I just don't know. I'm not the plaintiff or plaintiffs' counsel, so I think they know exactly what they think it's corrective of, and it's in the Complaint. I'm an economist just

highlighted that Ms. Allen hasn't demonstrated a lack of price impact.

So I don't -- as I sit here right now, I don't know whether those other categories of -- if you want to call them categories, misstatements and omissions are corrective or related to the Seeking Alpha and/or Susquehanna report.

Q. Do you see any connection between those other categories and misrepresentations and this disclosure?

MR. WHITMAN: Objection to form.

A. Yeah, I don't -- I don't -- I haven't thought about it in that level of detail. My understanding is that it's related to the transformational, world class resource play, driving incremental growth for years and years to come. I'm hedging a little bit with respect to the other ones. I just don't know right now.

Q. You mentioned that the Susquehanna report expressed a conclusion or belief that further cuts might be necessary at Apache and generally, that

things might get worse down the road; is that a fair summary of your understanding of what's corrective there?

MR. WHITMAN: Objection to form.

A. Plaintiffs allege this event, the Susquehanna report is related to the alleged misstatements, and what's corrective is -- I don't know what's corrective. I could tell you what happened. They did announce activity. Susquehanna says that while Apache had already announced activity reduction and slashed dividend payments, additional cutbacks may be necessary, and then they proceeded to downgrade the stock, cut its price target, and increase its expected net debt to EBITDA ratios.

Q. You read the Susquehanna report?

A. Yeah, I did.

Q. Does the Susquehanna report base its statement that they expect additional cutbacks may be necessary or its downgrade of the stock or its expected

increase in net debt to EBITDA ratios, does it base any of that on new information about Apache or Alpine High that was not known before March 16th?

MR. WHITMAN: Objection to form.

A. I think it's as alleged, it's because Alpine High was so unprofitable that it loaded the company up with tons of debt and that when a commodity price downturn hit, Apache was in particularly precarious position relative to its E&P peers, and that is relatively new information, if not new information, this day that prompted them to issue this report cutting price target and downgrading the stock's investment rating and increasing the net debt to EBITDA ratios.

Q. There was no information in here that was new about Alpine High's profitability or unprofitability, right? All that information about Alpine High's profitability or unprofitability was known well before March 16th?

MR. WHITMAN: Objection to

form.

A. I mean, the company's got a ton of debt and likely to get worse in this analyst opinion and plaintiffs are alleging that that's because of Alpine High's disastrous ramifications to the firm. I think that's the new information.

Q. But there's nothing new in here about Alpine High, right? There's no new information about Alpine High, that wasn't already known to the market?

MR. WHITMAN: Objection to form.

A. Alpine High as -- if its -- assuming plaintiffs' theory of liability is true, has put a lot of debt on the firm, and Susquehanna thinks it's going to get worst and it's not because of Suriname, because that's actually doing well and was going to be productive. Alpine High was not. It was pretty much defunct at that point.

So I guess that point is that this analyst made a conclusion and research, and researched the company and

determined that in its opinion, the debt load was going to get worse, the ability to pay off its debt was going to get worse and it's time to cut the stock and reduce its price target.

Q. The Susquehanna report itself doesn't even mention Alpine High, right?

A. I don't believe so.

Q. I heard you say earlier that you wrote some sort of dissertation or thesis or something on volatility; is that --

A. I did, yeah.

Q. This is going to be another area of statistics that you know more than me about -- more about than me.

Let's talk about volatility. What is the VIX or is it V-I-X or VIX?

A. I say VIX.

Q. What is the VIX?

A. It's changed over the years, but it's always been tauted as a measure of implied volatility. Used to be from options on the S&P-500. I think there's still a component to it, but I think

there's also time series analysis that underlies it. So it's -- but ultimately it's trying to measure market expectations of forward volatility over the next year.

Q. And how is volatility relevant to an economist like you performing an event study on a publicly traded stock?

A. The regression model estimates the standard error of the estimate, which is the volatility in a sense of the company specific returns during the control period, and it's used to determine whether a given return is statistically significant at a particular threshold or not.

Q. Ms. Allen in one of her reports says that on March 16, 2020, the VIX reached an all-time high; do you agree with that; is that a fact?

MR. WHITMAN: Objection to form.

A. I haven't looked at it, whether it's an all-time high. It was high, relatively speaking, quite high.

Q. What is -- is there a general, you know, threshold level that's -- you

know, if the VIX is between this number and this number, it's low, and if the VIX is above this number, it's high; is there just a general thought of what is a high VIX level across the years?

MR. WHITMAN: Objection to form.

A. I don't know. You can check, yeah, if anybody wanted to, you could download the VIX and check what the standard deviation is, what's the mean, what's the mode, what's the median, and figure out what the distribution looks like and get a sense of what's a -- how frequent returns are or how frequent the VIX levels are forward time.

Q. Let's look at Ms. Allen's surreply report at paragraph 73.

A. I'm there.

Q. Okay. So Ms. Allen says here in the middle of the paragraph, that volatility on March 16th, as measured by a VIX, was 83 percent; do you have any reason to dispute that?

A. No. Well, I guess I don't know

what that is. Is that 83 percent for the year or is that 83 percent -- I guess I don't know the scale of it.

Q. I believe it's on the day.

A. Well, it depends on the horizon. So if you're projecting volatility or estimating volatility for one year, it's going to be quite a bit larger than if you're forecasting the volatility over the next day. Return is compound, right, so you're going to -- it's just mathematical result. You're going to see the volatility than day returns.

Q. Are you familiar with the CBOE volatility index?

A. I'm not. I mean, I've heard of the CBOE and I've heard of volatility. Is that the VIX?

Q. That's the VIX. If you look at her notes and sources in the -- in the -- in the notes and sources to her -- to Ms. Allen's table at paragraph 73, you see that she mentions that a CBOE volatility index, VIX, is what was used to measure market volatility.

A. Got it.

Q. Ms. Allen in this surreply report, do you recall she determined what the volatility was during your shortest control periods that you used for your event studies?

MR. WHITMAN: Objection to form.

A. Are you talking about the table on paragraph --

Q. The table, right.

A. I can see a column that says market volatility during the control period and it's got like one, two, three, four, five covid-E oil price shock control periods right there.

Q. You've seen this table before?

A. Yes.

Q. And what Ms. Allen's done here, is she's shown in the left-hand column under Market Volatility, what the average volatility was during each of your -- I think you described them as covid E control periods?

A. I also said oil price shock,

but it's all -- so yes, I'm sorry, I have -- I see what's going on here.

Q. Okay. Do you have any reason to contest or dispute the numbers that she came up with in that column for your volatility during your control periods?

A. So I guess this goes with respect to all my opinions related to the surreply, I'm still digesting this. We just recently got the underlying data for her backup materials. So I'm not sure we've replicated it. And yeah, the one question I have sitting here today is whether these are annual or one-day volatilities or what.

Q. You at least as of now have not done any work to -- that would show these numbers to be wrong?

A. Yeah, not as I sit here today, I haven't replicated this table or found any problems with it.

Q. I believe Ms. Allen turned over her backup to her surreply report on October 18th, which was three weeks ago; is that around when you got it?

A. Maybe.
Q. You in your reply report talk about looking at a paper that was written by some authors at NERA, that you used to determine how to adjust for the heightened volatility on March 16th?
MR. WHITMAN: Objection to form.
A. Yes. Do we have that paper, by the way? You've got it as an exhibit today?
Q. Yeah, I do.
MR. LAWRENCE: Let's go ahead and throw that Up, Tony. It's Exhibit 7, and it's an article written on January 12, 2020 [sic].
A. Okay. Got it.
(Nye Exhibit 7, article "Testing for Materiality in Volatile Markets" was marked for identification, as of this date.)
BY MR. LAWRENCE:
Q. 2010, January 12, 2010.
A. That's correct.
Q. So this paper mentions four

different methods of controlling for volatility, correct?

MR. WHITMAN: Objection to form.

A. At least three possible solutions on page 4.

Q. Yeah. Well, did you look at the appendix?

A. Yes.

Q. Okay. If the appendix on page 7.

A. I'm on page 7.

Q. Okay.

A. Notes?

Q. No. Right by the end, Notes, end of the appendix.

A. Oh, right.

Q. There's an alternative to the simple approach also listed?

A. Yes.

Q. Okay. That's the fourth one, what I'm counting four. Three in the body.

A. I don't -- so there's two methods here, right. You can see in the bold. Market prediction for volatility for

disclosure dates and they give a model. Predict volatility for disclosure dates and they give the primary model. And they also describe at the, I guess, primary or simple approach can result in non-real numbers and negative predictions of volatility, which was obviously nonsensical.

So I read this alternative using GARCH model, which is totally unsupported. I don't see anybody ever using a GARCH model that has a log market volatility or implied volatility used in securities litigation or in academia. And this paper cites nothing to that effect. So this seems to be an alternative in case the -- using the projected VIX fails, so I read it as three possible solutions.

Q. Okay. And which of these solutions did you use in your reply report?

A. We use the first one, says move the estimation period forward to the event window, which is not a NERA breaking news situation. That is part and parcel with standard regression analysis is finding a control period to estimate your model,

which is modeling the period you're looking at, that is representative of that period.

So using a -- when there's over a structural break or some kind of really distinct change in the company's return generating process, it's best practices and the product of decades of event study research to use separate control periods for the pre and poststructural break.

So I view this first method as being robust, scientific and reliable in the product of decades of research and event studies, using a representative control period. So we've done that and I've shown sensitivity analysis of using two, three, four, and five-month periods that are from March 2020 and on, sort of capture that covid and oil shock related volatility. And that's why I chose that one.

I didn't choose the other two because they have no basis and they're not peer-reviewed. They're not -- there's no sources at all. This is an ad hoc kind of attempt to use implied volatility data to

substitute for parameters in a regression model that have no theoretical underpinnings at all.

Ordinarily squares regression, there's no place where you would replace the standard error as estimated within the -- you know, maximum likelihood estimation framework with an implied volatility number, that's not something you do, so that's why I didn't run these models.

Q. Did you -- did you attempt to run the models; did you try them at all?

A. I have recently and I know the results. I was suspicious when I saw no results in Ms. Allen's surreply. Would you like to know them?

Q. Tell me what -- tell me what results you have determined.

A. So I know we've got -- and Ms. Allen is really strict on the 95 percent confidence level. Using the first alternate method, which is obtain market expectation of volatility for disclosure dates, which that method is basically using Apache's implied volatility from the one

day before, so March 15th, using that. It's got -- so trying to correct for any market-wide volatility that could contribute to Apache's observed option implied volatility, so it's netting that out using a method that is not peer-reviewed at all.

But then it's got some kind of equation there and it's coming to an estimate of the company specific, quote unquote, option implied volatility for Apache. It then substitutes that right in there as the denominator for the calculation of the TSTAT, which is the residual return or company specific return, minus this option implied manipulated volatility.

Even so, even though this is not peer-reviewed, we're not even sure the applicability of using an option implied volatility that's projecting volatility over a full year. It's not a single day. It's not looking at the day. It's not an expectation of the March 16th volatility necessarily. It's the expectation over the

course of a year as implied by the Black-Scholes options pricing model, which has won a Noble price. It's a very good model. It's found routinely misestimate option or option prices, therefore, you have now an estimate of implied volatility that isn't even necessarily true. It's the product of many many assumptions and it's certainly not something you should insert into the ordinarily square root regression framework.

Even less, even if you do that, March 16th is still statistically significant at the 92 percent confidence level. If you carry that forward and also include March 17th, which plaintiffs allege using this methodology, it's significant at the 99.999 percent confidence level.

The next alternative is using the VIX as a means of projecting a forecast of Apache's implied volatility on March 16th. Excuse me. Same Black-Scholes problems exist. You're not sure whether you're getting an actual estimate of one year or one day. You're actually getting

an estimate of one year in terms of volatility, not one day.

You're also assuming that this relationship between the VIX and Apache's is a robust projection of Apache's volatility. There's been no analysis whatsoever to establish that. I think I should mention there's no analysis by Ms. Allen that these option prices from which these implied volatilities are estimated are efficient.

If they're not efficient, then this is a garbage estimate of Apache's volatility, which will result in a bias result in terms of statistical significant.

Nonetheless, if you run this model, you will find that similarly, that March 16, 2020 confidence level is, I think, at 92 percent and change again. And if you add March 17th, it jumps up to 99 percent. So I don't -- that's my problem with these models.

Q. Did you -- however we want to describe that last paragraph of the appendix, it gives an alternative to the

simple model; have you performed that analysis as well?

A. Yeah, I did look at it. I think it's insignificant, but it's -- there's no reason to run it because the first model works. The projection of -- it's not resulting in an non-real number or a negative volatility estimate, so why go on.

Even so, we're talking about three out of four methods, in this world, that there's four methods here, that show that there's a significant reaction at the 90 percent level at March 16th and if you add March 17th, it's significant at the 99 percent level.

Q. Have you, outside of the context of this case, had other occasions to be opining on or analyzing stock price movements in that -- I'll use your defined term of covid-E kind of March 16th week?

MR. WHITMAN: I just caution the witness not to disclose anything he's done for anybody in a purely consulting capacity, but you can

answer.

A. I got thrown by covid-E. I wish I hadn't said that. I didn't mean to make light of it at all. I shouldn't have said that. So I'd prefer we not say that. I apologize.

Q. Fair enough. We will no longer use that term.

A. Can you repeat the question because I got sidetracked.

Q. So outside of the context of this case, have you had other occasions that you're permitted to testify about, to be opining on or analyzing stock price movements in that mid-March 2020 time frame, where the covid pandemic and oil price shocks were having an impact, having the impact they had at that time?

MR. WHITMAN: Objection to form.

A. I think it might have come up in another case, but I -- I don't recall. It might not have too. I know I obviously encountered event studies involving this period, but I can't at the moment, at

least, remember other reports I filed in which I've attempted to model the return generating process in the March 2020 period. But I'll try to remember at a break, if I can think about it.

Q. Do your reports cite to or have you seen any analyst reports showing that any analyst changed its view during the focus period on the quantity of Alpine High's reserves or Alpine High's oil and wet gas versus dry gas reserve mix?

MR. WHITMAN: Objection to form.

A. On March 16th?

Q. During the focus period, we're zooming out.

A. Okay.

Q. So during the focus period -- I'll ask it again, if that's helpful.

During the focus period, did any analyst change its view on the quantity of Alpine High's reserves or Alpine High's oil and wet gas versus dry gas reserve mix?

MR. WHITMAN: Objection to form.

A. I haven't analyzed all the analyst reports and how their estimates of reserves and mix changed over the class period.

Q. Ms. Allen looked at that question in her first report, right?

A. I believe there's a section to that, some effect to that, yeah. I can't remember if she looked at all analyst reports. I definitely saw the one with Credit Suisse, but I'm not sure about whether there's a more comprehensive one out there.

MR. LAWRENCE: Let's take a quick break.

MR. WHITMAN: Five minutes.

THE VIDEOGRAPHER: The time is 12:46 p.m. We're going off the record.

(Whereupon, at this time, a short break was taken.)

THE VIDEOGRAPHER: The time is 12:57 p.m. We're back on the record.

MR. LAWRENCE: Dr. Nye, thank you for your time so far today. I

pass the witness.

MR. WHITMAN: Dr. Nye, I have no questions for you on behalf of plaintiffs and we appreciate your doing this today?

THE WITNESS: Thank you both. Appreciate your time.

THE VIDEOGRAPHER: Okay. Nobody else?

Okay. Then the time is 12:57 p.m. We're going off the record. Thank you everyone.

(Time noted: 12:57 p.m.)

J U R A T

I, ZACHARY NYE, do hereby certify under penalty of perjury that I have read the foregoing transcript of my deposition taken on November 8, 2023; that I have made such corrections as appear noted herein in ink, initialed by me; that my testimony as contained herein, as corrected, is true and correct.

____
ZACHARY NYE

Subscribed and sworn to before me
This _______ day of __________, 2023.

____
NOTARY PUBLIC

-----------------I N D E X-----------------

WITNESS: ZACHARY NYE

EXAMINATION BY PAGE

--------------E X H I B I T S--------------

NYE EXHIBIT FOR I.D.

C E R T I F I C A T E

STATE OF TEXAS)
: SS.:
COUNTY OF BELL)

I, AYLETTE GONZALEZ, a Notary Public for and within the State of Texas, do hereby certify:

That the witness, ZACHARY NYE, whose examination is hereinbefore set forth was duly sworn and that such examination is a true record of the testimony given by that witness.

I further certify that I am not related to any of the parties to this action by blood or by marriage and that I am in no way interested in the outcome of this matter.

IN WITNESS WHEREOF, I have hereunto set my hand this 9th day of November, 2023.

AYLETTE GONZALEZ

ERRATA SHEET FOR THE TRANSCRIPT OF:

Case Name: In re: Apache Corp. Securities
Dep. Date: November 8, 2023
Deponent: ZACHARY NYE

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ZACHARY NYE

SUBSCRIBED AND SWORN BEFORE ME,

This___ day of_____________, 2023.

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Notary Public

My Commission Expires:__________

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Exhibit 45

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Credit Rating Changes and Stock Market Reaction in the Kingdom of Bahrain

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Abstract

Between 2014 and 2015, the oil price almost halved. Since then, it has fallen a further 40%. Consequently, Moody's Investors Service has downgraded Bahrain's long-term issuer rating from Baa3 to Ba1with a negative outlook and placed it on review for further downgrade. In this context, previous literature reaches no agreement about the impact of credit rating changes on stock prices. Some studies indicate that credit rating changes do not affect stock prices, while others conclude they do. Therefore, this study aims to examine whether credit rating change has a significant impact on Bahraini stock prices. We conducted an event study to analyze stock market reaction to such news in the Kingdom of Bahrain. Even though Bahrain has witnessed a series of sovereign downgrades over the past five years, the latest downgrading event in February 17, 2016, has been followed by a credit rating downgrade of its banking sector in March 7, 2016. Hence the choice of the sample period of the event study includes both these downgrading events over the period of study from January 2, 2014 till March 22, 2016. Three sectors were selected from the Bahrain all share index: banks, service and industrial. The findings of the study reveal that sovereign rating downgrade has some mixed pre-announcement and post-announcement effects and credit rating downgrade provides useful information. Overall, the results indicate that downgrades and negative outlook announcements have an adverse impact on long-term equity returns, but little impact on short-term performance.

Keywords: credit rating changes, sovereign, stock prices, event study, Bahrain stock market

1. Introduction

Little evidence has been recorded on the analysis of information efficiency of ratings in the Gulf countries compared to the U.S. markets. The case of Kingdom of Bahrain is one of them and assessing the impact of rating actions on its market prices may add to the existing empirical literature. This may provide financial markets authorities with insights in utilizing external ratings as a regulatory tool in the Middle East region and Gulf countries.

Credit rating agencies, such as Moody's Investors Service or Standard & Poor's, play an important role in the financial markets and do typically impact investors' decisions (Gropp & Richards, 2001; Ferri & Morone, 2008). They also influence market prices of financial instruments that are available as investment vehicles for investors. Moreover, credit rating agencies display a pro-cyclical behavior in upgrading countries in good times and downgrading in bad times. This may reduce or magnify patterns in stock markets. Oil-exporting sovereigns like the Kingdom of Bahrain has been under a series of downgrading announcements impacting prices and affecting the pool of investors who hold investment grade instruments such as commercial bank stocks. In fact, persistent low oil prices have created a strong fiscal pressure on the government of Bahrain and lowered its capacity in supporting its banking sector when needs pop up. Effectively, such credit profile has been followed by a credit rating downgrade of five major commercial banks in the kingdom.

Standard & Poor's downgraded Bahrain's sovereign debt by two levels to BB on February 17, 2016, claiming that the collapse in oil prices would aggravate Bahrain's public finances. Later and in March 2016, Moody's Investors Service has announced a downgrade of Bahrain's sovereign rating from Baa3 to Ba1 with a perspective of further downgrade. The key driver for the rating downgrade is the highly negative effect of the slump in oil

prices, which is expected to last for many years, on Bahrain's government finances, balance of payments and economic performance. Furthermore, Bahrain's foreign currency bond ceiling has gone down from Baa1 to Baa2 and foreign currency deposit ceiling from Baa3 to Ba2. The short-term foreign currency bond ceiling went down from Prime-2 (P-2) to Prime-3 (P-3), as well as the short-term foreign-currency deposit ceiling that went down from P-3 to Not Prime (NP). Bahrain's local currency country risk ceilings were lowered to Baa1 from A3.

This paper investigates the credit rating changes and its effect on stock prices by analyzing specific Bahraini industries, banking, industrial, and service. These industries are selected because of their relative high market capitalization and trading volumes compared with the other existing industries in Bahrain stock market. This focus on specific industries may differentiate this analysis from other event studies conducted on analyzing credit rating changes and their effect on stock prices. It has been noticed that none of the existing companies included in the specific industries under investigation have investment grade bonds. Nevertheless, the banking sector includes five commercial banks having investment grade bonds and most of the events happened around downgrading announcements. Consequently, we analyze the downgrade that took place in the banking sector.

The rest of the paper is organized as follows: Section 2 wraps up a literature review that deals with the relation between credit rating changes and stock prices; Section 3 describes the research methodology; Section 4 presents the empirical analysis and test results of the relation between credit rating changes and stock prices; Section 5 provides summary and concluding remarks.

2. Literature Review

Numerous studies in the finance literature have investigated the impact of credit rating changes on capital markets in developed countries particularly in the U.S. Empirically, some studies have examined this impact on the price or return of bonds such as Katz (1974), Ederington et al. (1987), Goh and Ederington (1999). Another set of studies measured this impact on stocks, for example, Pinches and Singelton (1978), Holthausen and Leftwich (1986), Followill and Martell (1997), Jorion et al. (2005), Jorion and Zhang (2007). More recently some studies investigated the credit default swaps, such as Micu et al. (2004), and Cathcort et al. (2010). Moreover, few studies have also investigated the European market such as Gropp and Richards (2001), Cesare (2006) and single countries, for example, in UK, the study of Barron et al. (1997) and Batchelor and Manzoni (2006), in Germany, the study of Steiner and Heinke (2001), and in Spain, the study of Pilar and Dolores (2014). Reviewing all these studies clearly shows the diversity of the results of the responses to credit rating changes.

For example, Weinstein (1977) studies the behavior of corporate bond prices before and after the announcement of a credit rating change. The study indicates that the market should not expect that bond rating changes detect new information. In addition, 18 to 7 months before the announcement of the rating change, an evidence of price change was found. Contrarily, and 6 months prior to the announcement of a rating change, no price change was found. Nevertheless, the study shows little evidence price change 6 months post the announcement. These results are different for Wakeman (1978) who finds no price response using weekly bond returns and monthly stock returns.

Other studies reveal that bond rating downgrades do affect the stock price while upgrades do not. Griffin and Sanvicente (1982) determine that in most cases bond downgrades significantly induce a negative stock price reaction, while upgrades do not. They conclude that their results are in line with the logic that rating downgrades notify new information to the stock market. However, they do not set aside the fact that downgraded companies are already doing worse than normal and this paradigm just carries on after the downgrade.

Moreover, Holthausen and Leftwich (1986) report the existence of a link between credit rating downgrades and negative abnormal stock returns, while no link is found for upgrades. Using daily stock returns, and after controlling the simultaneous issues of news, they found negative significant abnormal returns during a 2-day event window. Similarly, Hand et al. (1992) report in their study on the US market that rating downgrades conveys new information to investors, while upgrades have no impact as news are already absorbed in the prices.

In addition, Goh and Ederington (1993) conclude similar findings, however they explain rating downgrades in more details, grouping downgrades into two types: those because of decay in the company's financial outlook and those because of an increase in leverage. Companies that are downgraded because of deterioration in company's financial prospects have a negative equity market reaction, whilst those because of increased leverage do not.

In a more recent study, Goh and Ederington (1999), examine the variability of the reaction to downgrade announcements in function of the implications for cash flows and the extent of surprise. The findings reveal a significant negative cumulative abnormal return (CAR) in a two-day event window around both downgrades and

upgrades announcement. The study relates downgrades with the existence of prior negative public information, while upgrades exist only because of public information.

Dichev and Piotroski (2001) examine the post announcement reaction by studying the price effect over a three year horizon. They divided downgrades and upgrades into two subsamples according to whether they belong to holding or subsidiaries. The findings were only significant for the downgrades. The post announcement impact lasts at least one year and is more evident for holdings, small companies and lower rated enterprises.

Jorion and Zhang (2007) investigate also the impact of rating changes on stock returns within a two-year event window. The results show that downgraded companies have a significant negative CAR, while upgraded companies display insignificant cumulative abnormal returns. However, and for upgrades of speculative grade issues, the results show a positive and significant average CAR but of a smaller magnitude than the downgrade effect.

Minardi (2008) claims that the information of credit rating is efficient in predicting Brazilian companies' default probabilities. Bone and Ribeiro (2009) examine the impact of rating changes in the Brazilian stock market over the period from 1995 to 2007. They check if rating change announcements affect systematic risk. The study uses the Chow stability test and shows no evidence of structural breaks pre or post the change. Further, Cisneros et al. (2012) report that credit rating agencies' reports are important and become of good quality since the improvements in the regulatory environment in Peru, Chile and Colombia.

To conclude, early studies on the impact of rating changes, using either daily or monthly data for the U.S. bond market, found either mixed evidence (such as Pinches & Singleton, 1978) or no effect at all (Weinstein, 1977; Wakeman, 1978). Their findings mainly conclude that most of the rating actions happen after the occurrence of publicly known events. Recent studies adopt a methodology that breaks down the rating actions into different subgroups based on whether they were foregone by a credit watch in the same direction or by inaccurate information. Hand et al. (1992), among the others, find out that only negative watches and downgrades significantly impact stock and bond prices. Therefore, this research effort may shed some light into the relationship between credit rating changes and stock market reaction in the Gulf area, particularly in the Kingdom of Bahrain. Hence, this study would motivate researchers to examine this relationship perhaps in some other Gulf countries such as Saudi Arabia, UAE, Kuwait, Qatar or Oman.

3. Methodology

This paper adopts an event study approach as proposed by Campbell, Lo, and Mackinlay (1997). Such approach is merely used by finance and economics scholars to determine the impact of an event on a particular variable of interest. This paper examines the event of a ratings downgrade for sovereign bond and a particular company's bond, and its impact on the stock price. However, before carrying such examination, it is important to determine how we expected the price to act if there was no event. There are a few alternatives for determining the expected return, and while some studies use an average of the returns over some period of time prior to the event, in this paper we use a market model, allowing us to make a more accurate prediction of expected return.

We use an event window equal to twenty days before (-20) and twenty days after (+20) the date of a rating change announcement (0). According to Ford, Jackson and Skinner (2010) and Freitas and Minardi (2013) the choice of the window should neither be too long nor too small such that it does not encompass other events and fails to capture abnormality in prices. Also, the literature does not seem to have a consensus in defining the event window. Dichev and Piotroski (2001) check different event windows: 0 (date of the announcement) to 3 months, to 6 months, to 1 year, to 2 years and to 3 years after the announcement. Jorion and Zhang (2007) checked the event window of 1 year before and after the announcement. Further, they tested different windows ranging from one to fifty days before and after an event.

To perform the event study, we first calculate the return on each asset i by equation (1), where ln is the natural logarithm, $P_{i,t}$ is the price of asset i on day t and $P_{i,t-1}$ is the price of asset i on day $t-1$.

$$R_{i,t} = ln(P_{i,t}/P_{i,t-1}) \tag{1}$$

We then estimate the returns over an estimation window that does not overlap with the event window and using the market model, which reads:

$$R_{i,t} = \alpha_i + \beta_i R_{m,t} + \varepsilon_{i,t} \tag{2}$$

Given the market model parameter estimates, we can measure the abnormal returns by equation (3), where $R^*_{i,t}$ and $R^*_{m,t}$ are the event-window returns of asset i on date t and the event-window market returns, respectively,

as follows:

$$AR_{i,t} = R^*_{i,t} - \hat{\alpha}_i - \hat{\beta}_i R^*_{m,t} \tag{3}$$

To draw overall inferences for the credit downgrading event, we aggregate the abnormal returns through time by calculating the cumulative abnormal returns over the entire event window. Taking τ_1 and τ_2 as two consecutive dates within the event window, we define the cumulative abnormal return for asset i in the following equation:

$$CAR_i(\tau_1, \tau_2) = \sum_{t=\tau_1}^{\tau_2} AR_{i,t} \tag{4}$$

We define the null and alternative hypotheses to determine whether the calculated CAR is significant as follows:

H_0: No abnormal return is observed in Bahraini industries' stock prices around the credit rating downgrade

H_1: An abnormal return is observed in Bahraini companies' stock prices around the credit rating downgrade.

We can now construct a test of H_0 for asset i to assess the significance of the abnormal returns using the standardized abnormal return in the following t-statistic as in Dodd (1980),

$$t\text{-stat} = \frac{AR_{i,t}}{\sigma_i} \tag{5}$$

with

$$\sigma_i = \sqrt{\frac{1}{N}\sum_{T=T_1}^{T_2}(AR_{i,T} - \bar{AR_i})^2} \tag{6}$$

and where N is the number of observations of the event window $(T_1, \ldots, 0, \ldots, T_2)$, and $\bar{AR_i}$ is the average event-window abnormal returns.

4. Analysis and Empirical Findings

Even though Bahrain has witnessed a series of sovereign downgrades over the past five years, the latest downgrading event in February 17, 2016, has been followed by a credit rating downgrade of its banking sector in March 7, 2016. Hence the choice of the sample period of the event study includes both these downgrading events. Additionally, the selection criteria for the inclusion of a given sector in the event study are based on market capitalization and industry representation. The Bahrain all share index has 45 listed companies and are spread in six sectors. As such, the sectors selected are banks, service, and industrial with a respective market capitalization of 47%, 15%, and 14.7% from a total market capitalization of $ 17.5 billion. Other sectors like investment, hotel and tourism, and insurance not only have the least industry representation but also displayed the lowest trading volumes over the period of study from January 2, 2014 till March 22, 2016. The source of the data of credit rating changes is Standard and Poor's and Moody's Investor Services, the two largest and oldest providers of ratings to the market, and the source of the data is GulfBase data provider. The main data consists of indices representing Bahrain stock market and its chosen sectors. The construction of these indices is price weighted and are available on a daily basis. Additionally, we select the sample based on the following criteria:

- Being a publicly traded company with stocks held by the major stock indexes in the kingdom of Bahrain as of 22/3/2016.
- Having experienced changes in issuer ratings or foreign currency long-term ratings by Moody's or S&P's between 02/01/2014 and 22/3/2016.
- If a listed company possesses more than one class of stock, we consider the class that has the highest average volume traded between 02/01/2014 and 22/3/2016
- We do not consider rating changes of companies whose stocks were not traded on dates close to the announcement.

Table 1 provides a descriptive statistic summary of the return series of the market and the three sectors under study. The average return is positive for the bank and service sector and negative for the market and the industrial sector. However, they are small compared to their respective volatilities. Despite the low volatility of Bahrain stock market (0.46%), the industrial sector has a higher volatility than the other sectors, which could be explained by the fact that Bahrain stock market is more connected to major stock markets in the world than its counterparts in the Gulf region. The distributions of the market and sector returns seem to be non-normal with a negative skewness and excess kurtosis showing fat tails, which is consistent with most emerging markets.

Table 1. Descriptive statistics for stock returns

	Market	Bank	Service	Industrial
Mean	-0.014	0.020	0.022	-0.011
Median	-0.016	0.021	0.000	0.000
Standard Deviation	0.460	0.962	0.804	2.375
Variance	0.212	0.925	0.646	5.640
Kurtosis	3.941	144.728	28.252	294.154
Skewness	-0.341	-8.515	-1.892	-14.404
Minimum	-2.842	-16.097	-8.219	-47.486
Maximum	1.537	3.685	4.283	10.032

The methodology described in the previous section uses the market model as the normal performance return model. The market model parameters are based upon daily return observations beginning 501 days through to 41 days before the sovereign rating change. The event period ranges from 20 days before to 20 days after the rating change. Table 2 summarizes the market model parameter estimates.

Table 2. Market model parameter estimates

Coefficient	Bank Sector	Service Sector	Industrial Sector
α	0.017	0.038	-0.004
β	0.182*	0.342*	0.452*
R^2	0.007	0.036	0.007

* Denotes 5% significance level.

On the premise that the literature has revealed that sovereign rating downgrade has some impact on stock market returns, the results displayed in Table 3 show some mixed pre-announcement and post-announcement effects. On the announcement day (day zero), the abnormal return for the bank sector is -0.066% and for both the service and industrial sector is -0.293% and -0.368% respectively, with no significant impact as the t-statistics accept the null hypothesis that the downgrading event has no impact. Focusing on the pre-announcement date, we observe an anticipation of the sovereign downgrade for the bank and industrial sectors only. There is a statistically significant reaction for the bank sector on day -16 with an abnormal return of -1.158%, and on day -8 and -7 for the industrial sector with respectively 2.587% and -2.930%. On the post-announcement date, we observe a significant effect on day 5 and 6 for the industrial sector with significant negative abnormal returns. Whereas, for the bank and service sector, it takes longer times to absorb the sovereign credit rating downgrade, respectively on day 16 and 18 for banks and day 19 for service. This would suggest that investors in the banking sector could earn significant positive returns sixteen days after the announcement as a possible overreaction but then realizing the negative outlook of the economy two days later. Investors in the industrial sector may have realized the negative outlook and have absorbed the announcement at an earlier time than with investors in the service sector. Nevertheless, the significant negative abnormal returns associated with the negative news of credit rating are in line with previous empirical studies. Overall, and within an interval of 5 days, the market seems to anticipate the information provided by the rating agencies as there are no significant abnormal returns whether earned by investing in the bank sector, the service or industrial sector.

In order to provide further insight to the results, we present the results of the effect of the credit rating downgrade of four out of the seven banks that constitute the bank sector portfolio, which took place on March 7, 2016, on all three sectors. The same methodology has been applied for this downgrading event and where the market model parameters are re-estimated based upon daily return observations beginning 511 days through to 21 days before the credit rating change. We observed no change in the parameter estimates carried out previously. The event period ranges from 10 days before to 10 days after the rating change. Table 4 presents the abnormal returns as well as the cumulative abnormal returns for the three sectors under study. The results are consistent with the empirical literature on the information content of credit rating change. There is supporting evidence that credit rating downgrade provides useful information. In fact, there is a significant negative reaction in both the bank sector and the industrial sector four days after the announcement. Whereas there is a delay of 8 to 9 days for the service sector.

Table 3. Cumulative abnormal return around sovereign rating downgrade

	Bank Sector			Service Sector			Industrial Sector		
Event Day	**AR**	**CAR**	**T Stats**	**AR**	**CAR**	**T Stats**	**AR**	**CAR**	**T Stats**
-20	-0.126	-0.126	-0.237	0.195	0.195	0.195	-0.101	-0.101	-0.095
-19	0.316	0.191	0.596	-0.420	-0.225	-0.419	-0.085	-0.186	-0.080
-18	-0.302	-0.111	-0.568	0.056	-0.168	0.056	0.416	0.229	0.390
-17	-0.476	-0.587	-0.897	-0.637	-0.805	-0.636	0.304	0.533	0.285
-16	-1.158	-1.745	**-2.181***	0.553	-0.253	0.551	0.596	1.129	0.559
-15	0.914	-0.831	1.723	0.112	-0.140	0.112	0.038	1.167	0.035
-14	0.113	-0.717	0.213	-0.281	-0.421	-0.280	0.329	1.496	0.308
-13	-0.990	-1.707	-1.865	-0.198	-0.619	-0.197	-0.206	1.289	-0.193
-12	0.829	-0.878	1.561	-0.109	-0.729	-0.109	0.514	1.803	0.482
-11	0.472	-0.406	0.889	0.122	-0.606	0.122	1.573	3.377	1.475
-10	0.375	-0.032	0.706	0.238	-0.368	0.238	-1.903	1.473	-1.784
-9	-0.352	-0.384	-0.663	-0.024	-0.392	-0.024	1.687	3.160	1.582
-8	0.247	-0.137	0.465	-0.553	-0.945	-0.552	2.587	5.747	**2.425***
-7	0.152	0.015	0.286	0.556	-0.389	0.554	-2.930	2.817	**-2.747***
-6	0.564	0.579	1.063	-0.287	-0.676	-0.286	-0.075	2.742	-0.070
-5	-0.004	0.575	-0.008	-0.077	-0.752	-0.076	-0.046	2.696	-0.043
-4	-0.126	0.449	-0.237	0.672	-0.081	0.670	-1.154	1.542	-1.082
-3	0.070	0.520	0.133	1.522	1.441	1.519	-0.053	1.489	-0.050
-2	-0.462	0.058	-0.871	0.056	1.498	0.056	0.000	1.488	0.000
-1	0.738	0.796	1.391	-0.384	1.114	-0.383	0.227	1.716	0.213
0	-0.066	0.730	-0.125	-0.293	0.821	-0.293	-0.368	1.348	-0.345
1	-0.338	0.391	-0.638	-0.070	0.751	-0.070	-0.262	1.086	-0.246
2	0.078	0.469	0.146	1.407	2.158	1.403	-0.204	0.882	-0.191
3	0.171	0.640	0.323	0.031	2.189	0.031	-1.698	-0.816	-1.591
4	0.434	1.074	0.817	-0.054	2.135	-0.054	-0.043	-0.859	-0.040
5	-0.133	0.941	-0.250	-0.356	1.779	-0.355	-2.070	-2.929	**-1.940***
6	-0.216	0.725	-0.407	-0.157	1.623	-0.156	2.614	-0.314	**2.451***
7	0.041	0.767	0.078	-0.091	1.532	-0.091	0.019	-0.295	0.018
8	-0.125	0.642	-0.235	-0.168	1.364	-0.167	-0.166	-0.462	-0.156
9	-0.135	0.507	-0.255	-0.117	1.247	-0.117	-0.832	-1.294	-0.780
10	-0.754	-0.248	-1.421	0.212	1.459	0.212	0.189	-1.105	0.177
11	0.670	0.422	1.261	0.236	1.695	0.236	-0.645	-1.750	-0.604
12	-0.122	0.300	-0.230	-0.054	1.641	-0.054	-0.074	-1.824	-0.069
13	0.546	0.846	1.029	-0.070	1.571	-0.070	0.099	-1.724	0.093
14	0.014	0.860	0.026	-0.296	1.276	-0.295	1.146	-0.578	1.074
15	-0.432	0.428	-0.814	-0.247	1.028	-0.247	-0.531	-1.109	-0.498
16	1.143	1.571	**2.153***	-0.310	0.718	-0.309	-0.012	-1.121	-0.012
17	-0.943	0.629	-1.776	0.488	1.206	0.487	-0.898	-2.019	-0.842
18	-1.058	-0.429	**-1.992***	-0.679	0.527	-0.678	-0.230	-2.249	-0.215
19	-0.185	-0.614	-0.349	-5.443	-4.916	**-5.430***	0.987	-1.262	0.925
20	-0.133	-0.748	-0.251	1.652	-3.264	1.648	0.131	-1.131	0.122

* Denotes 5% significance.

Table 4. Cumulative abnormal return around banks credit rating downgrade

	Bank Sector			**Service Sector**			**Industrial Sector**		
Event Day	**AR**	**CAR**	**T Stats**	**AR**	**CAR**	**T Stats**	**AR**	**CAR**	**T Stats**
-10	-0.571	-0.126	-0.544	0.592	0.592	0.864	-0.476	-0.476	-1.041
-9	0.046	-0.080	0.043	-0.607	-0.015	-0.886	-0.469	-0.945	-1.025
-8	0.078	-0.002	0.074	-0.145	-0.160	-0.211	-0.492	-1.437	-1.075
-7	-0.447	-0.449	-0.426	0.466	0.306	0.679	0.266	-1.171	0.581
-6	-0.388	-0.838	-0.370	-0.408	-0.102	-0.596	-0.392	-1.563	-0.857
-5	0.256	-0.582	0.244	-0.534	-0.637	-0.779	0.160	-1.403	0.351
-4	0.213	-0.369	0.203	0.182	-0.455	0.265	-0.501	-1.903	-1.094
-3	0.012	-0.357	0.011	-0.949	-1.404	-1.384	-0.071	-1.974	-0.155
-2	-0.063	-0.420	-0.060	0.203	-1.200	0.296	0.737	-1.237	1.610
-1	-0.452	-0.872	-0.431	0.125	-1.075	0.183	-0.026	-1.263	-0.057
0	0.626	-0.247	0.596	-0.890	-1.965	-1.298	0.507	-0.757	1.107
1	-0.953	-1.199	-0.907	0.232	-1.732	0.339	-0.830	-1.587	-1.815
2	-0.622	-1.821	-0.593	-0.402	-2.135	-0.587	0.337	-1.250	0.736
3	-0.104	-1.925	-0.099	-0.311	-2.445	-0.453	0.005	-1.246	0.010
4	3.207	1.282	**3.055***	1.152	-1.293	1.681	0.915	-0.330	**2.000***
5	0.433	1.715	0.413	-0.520	-1.813	-0.758	0.024	-0.306	0.053
6	0.401	2.117	0.382	-0.118	-1.931	-0.173	0.607	0.301	1.327
7	-2.308	-0.191	**-2.198***	0.142	-1.789	0.207	-0.120	0.180	-0.263
8	1.885	1.694	1.796	-1.590	-3.379	**-2.320***	-0.138	0.042	-0.302
9	-0.393	1.300	-0.375	-1.822	-5.201	**-2.657***	-0.245	-0.203	-0.535
10	0.878	2.178	0.836	0.142	-5.058	0.208	-0.547	-0.750	-1.196

* Denotes 5% significance level.

5. Conclusions

This study's main conclusion is that an emerging market such as of Bahrain could be seen as forward looking. Knowing that the oil price slump has triggered a series of fiscal pressures on the government, the sovereign downgrading has been expected by market participants and all of the anticipated market consequences of the downgrade are gradually factored into market prices over time, before a downgrade actually happens. Therefore, once the sovereign downgrade is announced, the market movements in the three sectors at the time are not significant. After the announcement, a much delayed significant reaction is witnessed in all three sectors. Such delay however was shorter when a credit rating downgrade is announced for the banking sector. In fact, learning that there is less willingness by the government of Bahrain to support its banks and a weakening of the bank operating conditions, investors in the bank sector and in the industrial sector seemed to be synchronized in displaying a negative reaction. Investors in the service sector seemed to react negatively days later. In a nutshell, this may suggest that downgrades and negative watches adversely impact long-term equity returns, and to a less extent short-term performance.

This study however presents some limitations as it is mainly limited to its small sample size. A larger sample, perhaps from different Gulf countries, with a greater number of observations would have allowed the results to give general insights. Another possible improvement would be in interviewing some policy makers, investors and professionals from the Kingdom of Bahrain (Abdeldayem, 2015). Personal interviews could elicit greater information regarding stock market reaction to credit rating changes in Bahrain. This method could have added important qualitative data and greater insight into the policy makers and investors' thoughts and opinions, so that better understanding and interpretation of the relation between credit rating changes and stock market reaction in the Kingdom of Bahrain would have achieved.

Although the relation between credit rating changes and stock market reaction has been established in the finance literature, to the authors' knowledge, this paper is the first of its kind to examine this issue in the Middle East and particularly in the Kingdom of Bahrain. The findings of this study are confined to one country in the Gulf area, i.e. the Kingdom of Bahrain, and this may limit the generalizability of its results. Hence, future research may conduct a comparative study or cross countries study perhaps in some other Gulf countries such as Saudi Arabia, UAE, Kuwait, Qatar or Oman, especially for examining the relationship between credit rating changes and stock market reaction. Moreover, the assessment of the price impact of rating actions for a particular

Gulf country, such as Bahrain, may serve for sensitivity checking of earlier research mainly based on U.S. data. Furthermore, it may provide insights for financial markets authorities involved in the evaluation of the usage of the external ratings as a regulatory tool in the Middle East region and Gulf countries.

References

Abdeldayem, M. M. (2015). Examining the Relationship between Agency Costs and Stock Mispricing: Evidence from the Bahrain Stock Exchange. *International Journal of Economics, Commerce and Management*, *3*(4), 1-35. Retrieved from http://ijecm.co.uk/wp-content/uploads/2015/04/342.pdf

Barron, M., Clare, A., & Thomas, S. (1997). The effect of bond rating changes and new ratings on UK stock returns. *Journal of Business Finance & Accounting, 24*(3), 497-509. http://dx.doi.org/10.1111/1468-5957.00117

Batchelor, R., & Manzoni, K. (2006). The dynamics of bond yield spread around rating revisions dates. *The Journal of Financial Research, 24*(3), 405-420. http://dx.doi.org/10.1111/j.1475-6803.2006.00186.x

Bone, R. B., & Ribeiro, E. P. (2009). *Conteúdo informacional dos ratings corporativos de empresasbrasileiras, 1995-2007*. Proceedings of the Brazilian Finance Meeting. São Leopoldo, Brazil, No. (9). http://dx.doi.org/10.11606/t.12.2006.tde-10042007-123346

Campbell, J. Y., Lo, A. W., & Mackinlay, A. C. (1997). *The econometrics of financial markets*. New Jersey, EUA: Princeton University Press. http://dx.doi.org/10.1007/bf02925377

Cathcart, L., El-Jahel, L., & Evans, L. (2010). *The correlation structure of the CDS market: An empirical investigation*. Unpublished manuscript. http://dx.doi.org/10.2139/ssrn.1571485

Cesare, A. (2006). Do market based indicators anticipate rating agencies? Evidence for international banks. *Economic Notes by Banca Monte deiPaschi di Siena SPA, 35*(1), 121-150. http://dx.doi.org/10.1111/j.0391-5026.2006.00161.x

Cisneros, D., Lizarzaburu, E. R., & Salguero, J. Q. (2012). Credit information in emergingmarkets: The rating agencies and credit risk reports, Peruvian experience. *International Journal of Business & Management, 7*(24), 35-43. http://dx.doi.org/10.5539/ijbm.v7n24p35

Dichev, I. D., & Piotroski, J. D. (2001). The Long-Run Stock Returns Following Bond Ratings Changes. *The Journal of Finance, 56*(1), 173-203. http://dx.doi.org/10.1111/0022-1082.00322

Dodd, P. (1980). Merger proposals, management discretion and stockholders wealth. *Journal of Financial Economics, 8*, 105-137. http://dx.doi.org/10.1016/0304-405x(80)90014-8

Ederington, L., Yawitz, J., & Roberts, B. (1987). The informational content of bond ratings. *The Journal of Financial Research, 10*(3), 211-226. http://dx.doi.org/10.1111/j.1475-6803.1987.tb00492.x

Fama, E. (1970). Efficient capital markets: A review of theory and empirical work. *The Journal of Finance*, (25), 383-417. http://dx.doi.org/10.2307/2325486

Feng, D., Gourieroux, C., & Jasiak, J. (2008). The ordered qualitative model for rating transitions. *Journal of Empirical Finance*, (15), 111-130. http://dx.doi.org/10.1016/j.jempfin.2006.12.003

Ferri, G., & Morone, A. (2008). *The effect of rating agencies on herd behavior.* Southern Europe Research in Economics Studies Working Paper No. (22). http://dx.doi.org/10.1007/s11403-013-0114-0

Followill, R., & Martell, T. (1997). Bond review and rating change announcements: An examination of informational value and market efficiency. *The Journal of Economics and Finance, 21*(2), 75-82. http://dx.doi.org/10.1007/bf02920766

Ford, G. S., Jackson, J. D., & Skinner, S. J. (2010). HAC standard errors and the event study methodology: A cautionary note. *Applied Economics Letters*, July 2010. http://dx.doi.org/10.1080/17446540902817601

Freitas, A. D. N., & Minardi,' A. M. F. (2013). The impact of credit rating changes in Latin American stock markets. *BAR, Braz. Adm. Review, 10*(4), Rio de Janeiro Oct./Dec. 2013. http://dx.doi.org/10.1590/s1807-76922013000400005

Goh, J. C., & Ederington, L. H. (1993). Is a Bond Rating Downgrade Bad News, Good News, or No News for Stockholders? *Journal of Finance*, (48), 2001-2008. http://dx.doi.org/10.1111/j.1540-6261.1993.tb05139.x

Goh, J., & Ederington, L. (1999). Cross sectional variation in the stock market reaction to bond rating changes. *The Quarterly Review of Economics and Finance, 39*(1), 101-112. http://dx.doi.org/10.1016/s1062-9769(99)80006-4

Gompers, P., Ishii, J., & Metrick, A. (2003). Corporate governance and equity prices. *Quarterly Journal of Economics*, *118*(1), 107-155. http://dx.doi.org/10.1162/00335530360535162

Gonzales, F., Haas, F., Johannes, R., Persson, M., Toledo, L., Violi, R., Zins, C., & Wieland, M. (2004). Market dynamics associated with credit ratings: A literature review. *Banque de France Financial Stability Review, 4*, 53-76. http://dx.doi.org/10.2307/2599542

Gopalan, R., Song, F., & Yerramilli, V. (2010). *Do credit rating agencies underestimates liquidity risk?* Working Paper Washington University, Pennsylvania State University, and Indiana University. http://dx.doi.org/10.5195/lawreview.2009.148

Griffin, P. A., & Sanvicente, A. Z. (1982). Common Stock Returns and Rating Changes: A Methodological Comparison. *The Journal of Finance*, (37), 103-119. http://dx.doi.org/10.2307/2327120

Gropp, R., & Richards, A. (2001). Rating agency actions and pricing of debt equity of European banks: What can we infer about private sector monitoring of bank soundness? *Economic Notes by Banca Monte deiPaschi di Siena SPA*, *30*(3), 373-398. http://dx.doi.org/10.1111/1468-0300.00064

Hand, J. R. M., Holthausen, R. W., & Leftwich, R. W. (1992). The Effect of Bond Rating Agency Announcements on Bond and Stock Prices. *The Journal of Finance, 47*(2), 733-752. http://dx.doi.org/10.1111/j.1540-6261.1992.tb04407.x

Hite, G., & Warga, A. (1997). The Effect of Bond-Rating Changes on Bond Price Performance. *Financial Analysts Journal*, May/June, 35-51. http://dx.doi.org/10.2469/faj.v53.n3.2083

Holthausen, R., & Leftwich, R. (1986). The Effect of Bond Rating Changes on Common Stock Prices. *Journal of Financial Economics*, *17*, 57-89. http://dx.doi.org/10.1016/0304-405x(86)90006-1

Jorion, P., & Zhang, G. (2007). Information effects of bond rating changes: The role of the rating prior to the announcement. *The Journal of Fixed Income, 16*(4), 45-59. http://dx.doi.org/10.3905/jfi.2007.683317

Jorion, P., Liu, Z., & Shi, C. (2005). Informational effects of regulation FD: Evidence from rating agencies. *Journal of Financial Economics*, (76), 309-330. http://dx.doi.org/10.1016/j.jfineco.2004.05.001

Jorion, P., Shi, C., & Zhang, S. (2009). Tightening credit standards: the role of accounting quality. *Review of Accounting Studies, 14*, 123-160. http://dx.doi.org/10.1007/s11142-007-9054-z

Katz, S. (1974). The price adjustment process of bonds to rating reclassification: A test of bond market efficiency. *The Journal of Finance, 29*(2), 551-559. http://dx.doi.org/10.1111/j.1540-6261.1974.tb03069.x

MacKinlay, A. C. (1997). Event Studies in Economics and Finance. *Journal of Economic Literature, 35*(1), 13-39. http://dx.doi.org/10.1016/1062-9769(95)90047-0

Micu, M., Remolona, E., & Wooldridge, P. (2004). The price impact of rating announcements: Evidence from the credit default swap market. *BIS Quarterly Review*, June, 55-65. http://dx.doi.org/10.2139/ssrn.911598

Minardi, A. M. A. F. (2008). Probabilidade de inadimplência de empresas brasileiras refletida nas informações do mercado acionário. *RAC Eletrônica, 2*(2), 311-329. http://dx.doi.org/10.11606/d.12.2008.tde-04062008-120550

Moody's Investors Service. (2002). *Understanding Moody's Corporate Bond Ratings and Rating Process*. May 2002.

Pilar, A., & Dolores, R. M. (2014). Credit rating agencies and idiosyncratic risk: Is there a linkage? Evidence from the Spanish Market. *International Review of Economics and Finance, 33*, 152-171. http://dx.doi.org/10.1016/j.iref.2014.05.002

Pinches, G., & Singleton, J. (1978). The adjustment of stock prices to bond ratingchanges. *The Journal of Finance, 33*(1), 29-44. http://dx.doi.org/10.2307/2326348

Standard & Poor's. (2009). *Use of credit watch and outlooks*. Annual Report. http://dx.doi.org/10.2139/ssrn.1462712

Steiner, M., & Heinke, V. (2001). Event study concerning international bond price effectsof rating actions. *International Journal of Finance & Economics*, *6*(2), 139-157. http://dx.doi.org/10.1002/ijfe.148

Wansley, J. W., Glascock, J. L., & Clauretie, T. M. (1992). Institutional Bond Pricing and Information Arrival: The Case of Bond Rating Changes. *Journal of Business Finance & Accounting*, *19*(5), 733-750. http://dx.doi.org/10.1111/j.1468-5957.1992.tb00654.x

Weinstein, M. (1977). The Effect of a Rating Change Announcement on Bond Price. *Journal of Financial Economics*, *5*, 329-350. http://dx.doi.org/10.1016/0304-405x(77)90042-3

Exhibit 46

THE SHORT-TERM EFFECT OF GOODWILL IMPAIRMENT ANNOUNCEMENTS ON COMPANIES' STOCK PRICES

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ABSTRACT

This study examines the short-term effect of goodwill impairment announcements on companies' stock prices. The substantial changes in accounting rules regarding goodwill impairment in recent years, as well as the expected increase in goodwill impairment announcements given the current COVID-19-driven economic downturn, make this evaluation relevant. The results of this study indicate that after the adoption of the most recent substantial change to goodwill accounting, accounting standards update (ASU) 2011-08, the stock price reaction to announcements of goodwill impairment is not statistically significant. Prior literature found that under previous accounting regulations there was a negative stock price reaction to impairment announcements, and that this effect had been decreasing as updates relaxing prior regulations' stringent testing procedures were implemented. The results of this study suggest that investors, following the recent accounting changes, find no new information in impairment announcements. these findings help inform decisions on whether the cost, complexity, and burden of goodwill impairment accounting can provide a compensating benefit.

Keywords: Goodwill impairment, stock price reaction; accounting standards update (ASU) 2011-08; market efficiency; event study

INTRODUCTION

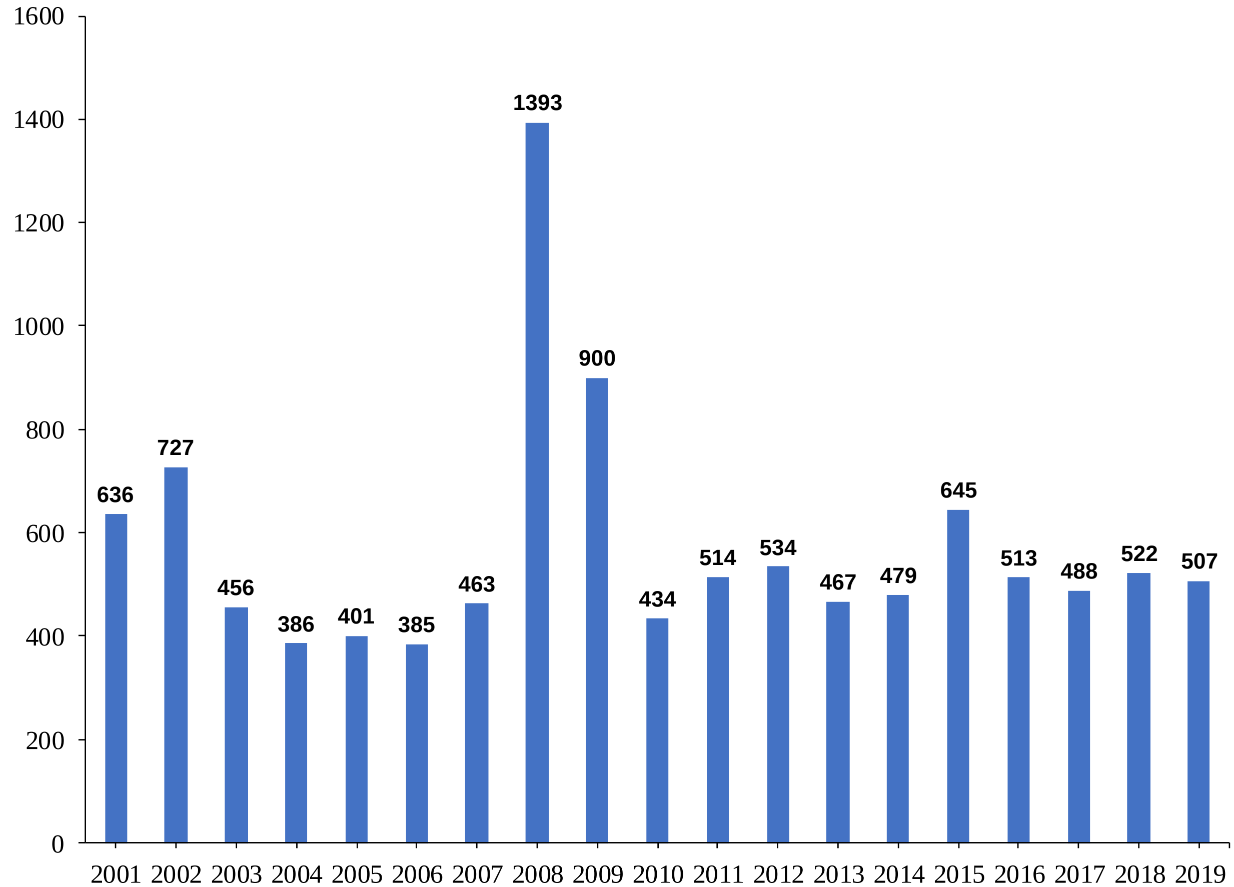
The global outbreak of COVID-19 and resulting lockdowns have led to record levels of unemployment and a slowdown in economic activity in the United States and around the world. The International Monetary Funds (IMF) have projected Gross domestic Product (GDP) to contract by 3% globally in 2020, which would make the current crisis the worst recession since the Great Depression.

Unsurprisingly, goodwill impairment announcements increase during economic downturns. For example, in 2008, the year of the global financial crisis, the number of goodwill impairments more than tripled compared to the 2007 level, from 463 to 1,393. Figure 1 shows the number of goodwill impairment announcements each year for all publicly traded companies in the United States from 2001 through 2019. Thus, given the COVID-19 pandemic, a substantial number of goodwill impairments is expected in 2020. In fact, in the month of May 2020 (the most recent completed month as of the writing of this paper), there were four times as many goodwill impairment announcements as in the same period in 2019 and 2018.

Before 1995, accounting rules did not specifically address the reporting of goodwill impairments. However, in the last 25 years, there have been three major changes related to regulations governing goodwill impairment accounting. First, Statement Financial Accounting Standards (SFAS) 121, effective on December 15, 1995, was the first set of accounting standards that directly addressed the impairment of long-lived assets. SFAS 121 required for the first time that companies "review long-lived assets and certain identifiable intangibles to be held and used for impairment whenever events or changes in circumstances indicate that the carrying amount

of an asset may not be recoverable" Financial Accounting Standards Board (FASB). (SFAS) 121 further required that impairment be tested for by estimating "the future cash flows expected to result from the use of the asset and its eventual disposition" (FASB, 1995). If the sum of the expected future cash flows (undiscounted and without interest charges) is less than the carrying amount of the asset, an impairment loss is recognized.

Figure 1
Number of Goodwill Impairments by Fiscal Year



Second, on December 15, 2001, SFAS 142 became effective, requiring that companies test for goodwill impairment at least annually and more frequently in certain circumstances, and eliminating the previous requirement that goodwill be amortized over a period of less than 40 years. In addition, the impairment testing methodology was updated, requiring companies to conduct a two-step process. The first step entails comparing the fair value of a reporting unit *as a whole* with its carrying amount. If its fair value exceeds the carrying amount, the reporting unit is not considered impaired; otherwise, the second step is required. The second step involves estimating the fair value of the reporting unit's *goodwill* and comparing it to the carrying value of that goodwill. If the fair value of the goodwill is less than its carrying value, an impairment is recognized.

Third, on December 15, 2011, ASU 2011-08 became effective, relaxing the requirements of SFAS 142 and allowing companies to first assess certain "qualitative factors" to determine

whether it is necessary to perform the two-step impairment test. ASU 2011-08 identifies several examples of these "qualitative factors," many of which are based on publicly available information, including a sustained decrease in the stock price, the deterioration of macroeconomic conditions, and increased competition in the industry. Although labeled "qualitative factors," these changes may have made the decision to test for goodwill impairment more objective and predictable, and thereby reduced not only the cost of performing the analysis but also the informational content of goodwill announcements.

Although there are a large number of goodwill impairments each year and substantial interest in this topic from companies, investors, and academics, there is no easy answer from a theoretical perspective as to whether goodwill impairments should have an impact on stock prices. On the one hand, a goodwill impairment is a one-time, non-cash, bookkeeping adjustment that does not directly affect a company's cash flow. On the other hand, a goodwill impairment may reveal additional information regarding a company's future prospects. This is further complicated by the fact that goodwill impairment testing is inherently subjective, raising questions about the value of goodwill impairment announcements to investors. Therefore, the goal of this study is to empirically examine the stock price reaction to the announcement of goodwill impairments since the introduction of ASU 2011-08.

One recently implemented change to goodwill impairment testing requirements not covered in this study is ASU 2017-04, which further loosened the accounting standards concerning goodwill impairment, removing the need for the second step of the two-step impairment test. This change indicates a clear trend toward reducing the cost and complexity of impairment testing and acknowledges that the informational value of goodwill impairments may be limited. In light of this trend, this study may add fuel to the argument that calculations of goodwill and its impairments should be eliminated altogether. Goodwill accounting's differential treatment of companies that grow through acquisitions versus companies that grow organically places a higher burden on the former group with arguably no compensating benefit.

LITERATURE REVIEW

The literature is in general agreement that the question of whether goodwill impairments reveal material information to market participants should be answered empirically, as there is no definitive answer from a theoretical perspective. Hirschey and Richardson (2002) state that asset write-offs tend to be ambiguous in the information they convey. Li, Shroff, Venkataraman, and Zhang (2001) note that while a goodwill impairment may convey some new information to investors, "the impairment loss may not convey new information, if the economic loss in the value of goodwill occurred in prior periods and was impounded in the market price before its actual recognition in the income statement."

Li, et al (2001) also point out that the inherent subjectivity in estimating the impairment loss could reduce the information content of the impairment loss. Glaum, Landsman, and Wyrwa (2018) suggest that management can use their discretion opportunistically, and that "[u]ltimately, it is an empirical question whether goodwill impairment losses reflect, in a timely manner, declines in the economic values of firms' goodwill balances." Similarly, Jarva (2009) concludes that "it is an empirical question whether goodwill charges contain information about expected future cash flows."

None of the literature has measured the short-term stock price reaction to the announcement of goodwill impairments since the introduction of ASU 2011-08 in December

2011. The prior literature found that under the old accounting regimes there was a negative stock price reaction to impairment announcements, but that this effect had been decreasing as new accounting rules were implemented. Hirschey and Richardson (2002), using data from 1992 to 1996, before the adoption of the first goodwill impairment standards (SFAS 121), find that "information effects narrowly tied to goodwill write-off announcements are typically negative and material, on the order of 2-3% of the company's stock price."

Later studies find that the effects have been decreasing with the introduction of new accounting rules regarding goodwill impairment. Li, Shroff, Venkataraman, and Zhang (2011), using data from 1996 to 2006, covering the periods after the adoption of the first and second major changes to goodwill impairment standards (SFAS 121 and SFAS 142), find that "[t]he price impact of [an] impairment loss, while significant, is lower in the post-SFAS-142 period relative to the pre-SFAS-142 period and transition periods." Cheng, Peterson, and Sherrill (2015), using post-SFAS-142 data from 2002 to 2011, find that the long-term impact of goodwill impairments on stock returns is positive and economically significant, even though there is a small, short-term negative impact.

Li and Sloan (2017) also find "that the magnitude of the market reaction is smaller in the post-SFAS 142 period." The focus of Li and Sloan (2017) was the impact of SFAS 142; however, as a robustness analysis they use data after the passage of ASU 2011-08 to measure the *long-term* price reaction to goodwill impairment announcements, finding that "investors have more efficiently anticipated delayed goodwill impairments since the passage of ASU 2011-08."

Prior literature found that under previous accounting regulations there was a negative stock price reaction to impairment announcements, and that this effect has been decreasing as updates relaxing prior regulations' stringent testing procedures were implemented. This study hypothesizes that after the adoption of ASU 2011-08, the information effects of goodwill impairments announcements will no longer be observable. In other words, this study hypothesizes that after the adoption of ASU 2011-08, the stock price reaction to announcements of goodwill impairment not accompanied by an earnings surprise will not be statistically significant.

METHODOLOGY

FactSet Research Systems was used to identify publicly traded U.S. companies that recorded goodwill impairments during fiscal years 2015 through 2017. For each of these companies, data on stock prices, market capitalizations, total assets, announcement dates, and impairment amounts were collected. Companies with a market capitalization of under $50 million (measured the day before the goodwill impairment announcement) were excluded. Companies that had impairments representing less than 1% of the company's total assets (measured the quarter before the goodwill impairment announcement) or 1% of the company's market capitalization were also excluded. If a company has multiple goodwill impairment announcements, only the announcement with the largest impairment amount is included.

Similar to the methodology used in Hirschey and Richardson (2002), this study limits the effect of confounding information by focusing on goodwill impairment announcements that were not accompanied by earnings surprises. In particular, this study is limited to goodwill impairment announcements where any concurrent earnings surprise (defined as the percentage difference between the actual adjusted earnings before interest, taxes, depreciation, and amortization (EBITDA) announced and analyst consensus adjusted EBITDA)is smaller than 2%. Data on

actual adjusted EBITDA and analyst consensus adjusted EBITDA are obtained from the Institutional Broker's Systems (IBES) via FactSet Research Systems. Companies with missing relevant earnings surprise data are excluded.

To test whether there is a short-term stock price reaction to goodwill impairment announcements, an event study analysis was performed. The cumulative abnormal return (CAR) associated with each of the goodwill impairment announcements of the firms in the sample was calculated and the sample's mean CAR was tested for statistical significance. This methodology is similar to the methodology used in Cheng, Peterson, and Sherrill (2017).

To calculate the abnormal returns, a market model was estimated for each of the firms using the daily returns of the firm's stock as a function of the daily returns of the S&P 500 Index. The model is estimated by running a regression over a control period of one year prior to each announcement (approximately 252 trading days). The abnormal return on the days surrounding each impairment announcement for each firm was calculated by taking the difference between the actual return of the stock and the predicted return. Then, the CAR was calculated as the sum of abnormal returns from the day before the announcement to the day after the announcement, as shown in the equation below.

$$CAR_i = \sum_{n=-1}^{1} \left(R_{i,t+n} - \hat{R}_{i,t+n}\right) \#(1)$$

CAR_i is the CAR of sample firm i, R is the actual stock return, $\hat{R}$ is the estimated stock return, $t-1$ is the day before the announcement date, t is the day of the announcement date, and $t+1$ is the day after the announcement date.

RESULTS

In total, the study analyzed 38 announcements of goodwill impairments (ranging from $13.2 million to $4.2 billion). Table 1 reports the summary statistics of the 38 firms included in the sample. The list of companies and announcements is presented in Appendix 1.

Table 1
Summary Statistics

Variable	**Mean**	**Median**	**Std Dev**	**Min**	**Max**
Goodwill Impairment ($ millions)	$568	$258	$780	$13	$4,165
Market Cap. ($ millions)	$7,136	$1,921	$13,278	$69	$70,398
Impairment as % of Total Assets	8.3%	4.9%	7.4%	1.0%	28.9%
Impairment as % of Market Cap.	88.3%	6.9%	234.6%	1.1%	1289.7%
EBITDA Surprise	0.1%	0.5%	1.0%	-1.8%	1.5%

The mean CAR of all 38 companies in the sample is 0.27%, with a t-statistic of 0.20. In other words, the results indicate that the short-term price reaction associated with goodwill

impairments of the sample firms is not statistically significant.These statistical results are consistent with an observable lack of interest among financial analysts regarding goodwill impairment announcements. In particular, the authors of this study performed a review of sell-side analyst reports issued immediately after the goodwill impairment announcements for the companies in the sample that had statistically significant negative CARs.

It is clear from the review that the analysts did not place much, if any, focus on goodwill impairment announcements. The analysts did not factor the amount of impairment into their valuations, generally basing their valuations on adjusted EBITDA, which excludes non-recurring charges such as goodwill impairments.

CONCLUDING REMARKS

This study examined the short-term stock price reaction to announcement of goodwill impairments after the adoption of ASU 2011-08. The results suggest that investors, following the most recent accounting changes, find no new information in impairment announcements. ASU 2011-08 identifies several "qualitative factors" that can be considered when evaluating whether it is necessary to perform an impairment test. Many of those "qualitative factors" are based on publicly available information, including a sustained decease in the stock price, the deterioration of macroeconomic conditions, and increased competition in the industry. Investors can analyze those qualitative factors and make their own determinations on the likelihood of an impairment prior to any announcement by the company.

Following ASU 2011-08, one recently implemented change is ASU 2017-04, which further loosened the accounting standards concerning goodwill impairment, removing the need for the second step of the two-step impairment test. The transition to ASU 2017-04 officially started in 2020 and will last until 2022. In implementing this change, the Financial Accounting Standards Board (FASB) acknowledges that "many users have indicated that the most useful information is knowing whether an impairment charge is warranted, not the precise amount of that impairment" and that the drawbacks of the second step (i.e., its cost and complexity) outweighed the benefits of the test (i.e., precision and accuracy) (FASB, 2017). This change indicates a clear trend toward reducing the cost and complexity of impairment testing and acknowledges that the informational value of goodwill impairments may be limited, which is consistent with the results of this study.

Given the economic downturn caused by the COVID-19 pandemic, the expected increase in goodwill impairment announcements, and the further loosening of the accounting standards concerning goodwill impairment, the value of goodwill impairment announcements to investors will likely continue to decrease, making the costs associated with goodwill impairment tests harder to justify. This may add fuel to the argument that calculations of goodwill and its impairments should be eliminated altogether. Goodwill accounting's differential treatment of companies that grow through acquisitions versus companies that grow organically places a higher burden on the former group with arguably no compensating benefit.

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REFERENCES

Cheng, Y., Peterson, D., & Sherrill, K. (2017). Admitting mistakes pays: the long term impact of goodwill impairment write-offs on stock prices. *Journal of Economics and Finance*, *41*(2), 311-329.

Financial Accounting Standards Board (FASB). (1995). *Statement of financial accounting standards no. 121: Accounting for the impairment of long-lived assets and for long-lived assets to be disposed of.* Norwalk, CT: FASB.

Financial Accounting Standards Board (FASB). (2001). *Statement of financial accounting standards no. 142: Goodwill and other intangible assets.* Norwalk, CT: FASB.

Financial Accounting Standards Board (FASB). (2011). *Accounting standards update no. 2011-08: Intangibles-goodwill and other (topic 350).* Norwalk, CT: FASB.

Financial Accounting Standards Board (FASB). (2017). *Accounting standards update no. 2017-04: Intangibles-goodwill and other (topic 350).* Norwalk, CT: FASB.

Glaum, M., Landsman, W. R., & Wyrwa, S. (2018). Goodwill impairment: The effects of public enforcement and monitoring by institutional investors. *The Accounting Review*, *93*(6), 149-180.

Hirschey, M., & Richardson, V. J. (2002). Information content of accounting goodwill numbers. *Journal of Accounting and Public Policy*, *21*(3), 173-191.

Jarva, H. (2009). Do firms manage fair value estimates? An examination of SFAS 142 goodwill impairments. *Journal of Business Finance & Accounting*, *36*(9-10), 1059-1086.

Li, K. K., & Sloan, R. G. (2017). Has goodwill accounting gone bad? *Review of Accounting Studies*, *22*(2), 964-1003.

Li, Z., Shroff, P. K., Venkataraman, R., & Zhang, I. X. (2011). Causes and consequences of goodwill impairment losses. *Review of Accounting Studies*, 16(4), 745-778.

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Appendix 1
Goodwill Impairment Announcements

Company	Date	Impairment ($ millions)	Impairment (% Market Cap.)	Impairment (% Total Assets)
Aegion Corporation	11/1/17	$45	6%	4%
Aon plc	8/4/17	$380	1%	1%
Applied Industrial Technologies, Inc.	4/28/16	$65	4%	5%
Archrock Partners LP	2/25/16	$128	31%	6%
Ascena Retail Group, Inc.	6/8/17	$1,324	367%	25%
Axiall Corporation	11/3/15	$848	57%	15%
Bemis Company, Inc.	2/1/18	$197	5%	5%
Booking Holdings Inc.	11/7/16	$941	1%	5%
CEB Inc.	3/1/17	$68	3%	5%
Crestwood Equity Partners LP	11/3/15	$610	30%	8%
DaVita Inc.	2/11/16	$206	2%	1%
Dentsply Sirona, Inc.	8/9/17	$1,173	8%	10%
Dine Brands Global, Inc.	11/9/17	$532	69%	24%
Eldorado Resorts Inc	2/22/18	$38	2%	1%
Enbridge Energy Partners, L.P.	7/30/15	$247	2%	1%
Frontier Communications Corporation	2/27/18	$2,078	287%	8%
Haemonetics Corporation	2/1/16	$66	4%	5%
Intelsat S.A.	2/22/16	$4,165	1290%	25%
Internap Corporation	11/3/16	$78	113%	14%
j2 Global, Inc.	2/6/18	$58	2%	3%
Kinder Morgan Inc	1/20/16	$1,150	4%	1%
Lands' End, Inc.	3/21/17	$173	28%	13%
LSC Communications, Inc.	11/2/17	$55	10%	3%
Meredith Corporation	7/28/16	$156	6%	6%
Mistras Group, Inc.	11/6/17	$13	2%	3%
Nasdaq, Inc.	1/31/17	$578	5%	4%
Pandora Media, Inc.	7/31/17	$132	6%	12%
Pinnacle Entertainment Inc	8/9/16	$462	75%	10%
Platform Specialty Products Corp.	2/27/18	$160	5%	2%
Roadrunner Transportation Systems, Inc.	11/2/16	$372	129%	29%
SeaWorld Entertainment, Inc.	8/8/17	$269	22%	11%

Company	**Date**	**Impairment ($ millions)**	**Impairment (% Market Cap.)**	**Impairment (% Total Assets)**
Time, Inc.	11/5/15	$952	46%	16%
Townsquare Media, Inc.	3/13/18	$52	37%	5%
Watts Water Technologies, Inc.	2/16/16	$130	7%	7%
Western Union Company	2/13/18	$464	5%	5%
Williams Companies, Inc.	2/17/16	$1,098	10%	2%
Windstream Holdings, Inc.	2/22/18	$1,841	676%	14%
Zimmer Biomet Holdings, Inc.	1/30/18	$272	1%	1%
Mean		$568	88.3%	8.3%

Exhibit 47

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NOTE

Single-Firm Event Studies, Securities Fraud, and Financial Crisis: Problems of Inference

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Abstract. Lawsuits brought pursuant to section 10(b) of the Securities and Exchange Act depend on the reliability of a statistical tool called an event study to adjudicate issues of reliance, materiality, loss causation, and damages. Although judicial acceptance of the event study technique is pervasive, there has been little empirical analysis of the ability of event studies to produce reliable results when applied to a single company's security.

Using data from the recent financial crisis, this Note demonstrates that the standard-model event study used in most court proceedings can lead to biased inferences sanctioned through the Daubert standard of admissibility for expert testimony. In particular, in the presence of broad market volatility, a base event study will cause too many returns to be identified as statistically significant. Even recently proposed variations of the event study model specifically designed to address violations of the statistical assumptions of an event study will not completely correct this bias. This Note proposes two alternative forms of event studies that are capable of creating statistically reliable results and should be adopted by courts in instances where there is cause to believe that market volatility has increased.

Over previous decades, the judiciary has steadily moved toward a reliance on empirics and expert testimony in overseeing complex civil cases. Yet there has been surprisingly little research accompanying this judicial deference on the ability of statistical evidence to produce the promised result. This Note calls into question whether this movement has been beneficial from a logical or empirical perspective, but it demonstrates that alternative techniques that can aid the finder of fact in resolving these disputes—regardless of market trends—may in fact exist.

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Single-Firm Event Studies, Securities Fraud, and Financial Crisis
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Introduction

An event study is a technique used to analyze the effect of a predetermined "event" on the value of a company's security.[1] The event effect is determined by comparing the actual return of the security to that predicted by an econometric model incorporating changes in a market index and the security's historical comovement with the market. Given the technique's ability to isolate firm-specific movements in the price of a company's security, modern courts effectively require a plaintiff to provide a methodologically sound event study to prevail on both a class certification motion and the merits.

Event studies are appropriated from a larger literature in financial economics, in which they are traditionally used over a broad set of securities for a specific form of event that generally occurs across time periods.[2] The statistical assumptions underlying interpretation in this context are often robust to the typical econometric concern of model choice. While judicial reliance on the event study has progressed inexorably, surprisingly little research has been devoted to analyzing the statistical properties and suitability of an event study used for a single security and for a limited number of events.

Early articles comparing different event study techniques found model performance to be indifferent to methodological choice.[3] However, financial economists have long been aware that increases in market volatility can lead to biased tests of statistical significance and corresponding difficulties in interpretation.[4] Beginning in August 2007, an unprecedented credit crisis hit U.S. financial markets,[5] causing a significant spike in overall market volatility. Based on an empirical analysis of the results of competing event study models over the crisis period, this Note demonstrates that standard methods for analyzing the returns of a single security generate too many statistically significant excess returns, which will cause courts to find event effects where none may exist.[6] However, there are alternative models capable of providing results robust to increased security variance by explicitly controlling for changes in marketwide volatility. This suggests that courts should approach

1. *See* Michael J. Kaufman & John M. Wunderlich, *Regressing: The Troubling Dispositive Role of Event Studies in Securities Fraud Litigation*, 15 STAN. J.L. BUS. & FIN. 183, 188 (2009).

2. *See* S.P. Kothari & Jerold B. Warner, *Econometrics of Event Studies*, *in* 1 HANDBOOK OF CORPORATE FINANCE: EMPIRICAL CORPORATE FINANCE 3, 8-9 (B. Espen Eckbo ed., 2007).

3. *See* Stephen J. Brown & Jerold B. Warner, *Measuring Security Price Performance*, 8 J. FIN. ECON. 205, 249 (1980).

4. *See, e.g.*, Stephen J. Brown & Jerold B. Warner, *Using Daily Stock Returns: The Case of Event Studies*, 14 J. FIN. ECON. 3, 23 (1985).

5. *See* Jill Treanor, *Credit Crunch Pinpointed to 9 August 2007—The Day the World Changed*, GUARDIAN (Dec. 1, 2011, 3:49 PM EST), http://gu.com/p/33npx/stw.

6. See Part II.A below for an overview of event studies and their use in securities litigation.

unadjusted event study results with caution when provided by expert witnesses to explain security performance over periods with known changes in market volatility.

The consequence of accepting biased event study results is magnified by the increased reliance on empirics in adjudicating complex legal disputes. Over the past several decades, courts have relinquished many tasks traditionally confined to the judiciary in favor of ostensibly objective statistical analysis.[7] In order to understand the interplay between event study analysis and securities fraud doctrine, the structure of this Note is as follows: Part I describes the historical development of the modern securities fraud class action, Part II explains the role of expert testimony in the disposition of a suit, Part III details the extant literature on event studies, and Part IV provides a description of the data and empirical methodology used in this Note to compare event study models. In particular I will use both Type I and Type II error tests to compare the specification of competing event study models. Part V presents the results of the comparative event study model analysis.

I. Historical Development of Securities Fraud Lawsuits

A general understanding of the history and theory underlying modern doctrine is necessary to appreciate the prominent role performed by event studies in the securities fraud framework. The structure of securities class action suits developed through decades of statutory enactment, judicial experimentation, and evolving economic theory. The resulting standard for a cause of action depends critically on an empirical analysis of asset price guided by the tenets of a debatable economic theory. Due to this reliance on econometric analysis, courts require expert economic testimony to satisfy the majority of the factual determinations of a case—with a particular reliance on

7. See Parts I.B and I.A.2 below for a discussion of how reliance and materiality in securities litigation are now essentially empirical questions. *See also* Thomas J. Campbell, *Regression Analysis in Title VII Cases: Minimum Standards, Comparable Worth, and Other Issues Where Law and Statistics Meet*, 36 STAN. L. REV. 1299, 1311 (1984) (noting that the Supreme Court sanctioned a "two-standard-deviations rule" for assessing the representation of minority groups in employment discrimination cases); D.H. Kaye, *Statistical Analysis in Jury Discrimination Cases*, 25 JURIMETRICS J. 274 (1985) (describing the use of statistical evidence to test the constitutionality of jury composition under the Fifth, Sixth, Seventh, and Fourteenth Amendments). Recently there has been judicial pushback, as judges have questioned the probativeness of statistical evidence in certain contexts. *See, e.g.*, Wal-Mart Stores, Inc. v. Dukes, 131 S. Ct. 2541, 2555 (2011) (discounting statistical evidence of companywide employment discrimination that incorporated evidence of disparate impact and aggregated regional and national data); Exxon Shipping Co. v. Baker, 554 U.S. 471, 501 n.17 (2008) (refusing to rely on experimental evidence using "mock juries" that was partially funded by the defendant). I thank Dan Ho for bringing this to my attention.

the use of event studies in establishing market efficiency, price distortion, and loss causation.

A. Statutory Underpinnings and the Judicial Creation of a Private Cause of Action

Private securities litigation is grounded in regulations enacted to ensure open and transparent securities markets.[8] Congress implemented two critical articles of legislation in the aftermath of the stock market crash of 1929: the Securities Act of 1933[9] and the Securities Exchange Act of 1934.[10] The Securities Act applies standards for the registration and distribution of securities, while the Exchange Act regulates secondary trading markets[11] and includes the continuous, periodic reporting requirements for securities issued under various Securities and Exchange Commission (SEC) provisions.[12] The overarching objective of both statutes is to guarantee the "full and fair disclosure" of information critical to the integrity of the market.[13]

Although suits do arise under the Securities Act, particularly section 11,[14] section 10 of the Exchange Act has become the statutory workhorse for private suits alleging fraudulent misstatements or omissions.[15] Section 10(b) of the Exchange Act stipulates that it is unlawful

> [t]o use or employ, in connection with the purchase or sale of any security registered on a national securities exchange or any security not so registered, or any securities-based swap agreement any manipulative or deceptive device or contrivance in contravention of such rules and regulations as the [Securities and

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8. *See* John Hanna, *The Securities Exchange Act as Supplementary of the Securities Act*, 4 LAW & CONTEMP. PROBS. 256, 256-57 (1937).
9. Pub. L. No. 73-22, tit. I, 48 Stat. 74 (codified as amended at 15 U.S.C. §§ 77a-77aa (2014)).
10. Pub. L. No. 73-291, 48 Stat. 881 (codified as amended at 15 U.S.C. §§ 78a-78pp). Although both the Securities Act and the Securities Exchange Act (or "Exchange Act") have been modified over the years, their role in the regulatory framework of the securities market has remained constant.
11. *See* Hanna, *supra* note 8, at 256-57.
12. *See* Stefan J. Padfield, *Who Should Do the Math?: Materiality Issues in Disclosures that Require Investors to Calculate the Bottom Line*, 34 PEPP. L. REV. 927, 931 (2007).
13. *Id.*
14. *See* Frederick C. Dunbar & Dana Heller, *Fraud on the Market Meets Behavioral Finance*, 31 DEL. J. CORP. L. 455, 459 (2006) (noting that section 11 is the most commonly used provision of the Securities Act and ascribes liability for misleading statements or omissions of material facts in the registration statement of a security); *see also* Securities Act of 1933 § 11, 15 U.S.C. § 77k.
15. *See* Jennifer J. Johnson, *Secondary Liability for Securities Fraud: Gatekeepers in State Court*, 36 DEL. J. CORP. L. 463, 465 (2011) (noting that section 10(b) of the Exchange Act and Rule 10b-5, which was promulgated under section 10(b), are "the most widely utilized antifraud provisions in the federal securities laws").

> Exchange] Commission may prescribe as necessary or appropriate in the public interest or for the protection of investors.[16]

The benefits of this section of the statute are subtle but significant—Congress intended for it to function as a "catch-all" provision allowing the SEC to expand its authority into evolving realms of fraudulent practice.[17] Although there was no congressional intent to provide a private cause of action in passing the Exchange Act, federal courts interpreted such a right as "implied in the words of the statute and its implementing regulation."[18]

In 1942, consistent with the requirements of section 10(b), the SEC promulgated Rule 10b-5, which made it unlawful to "make any untrue statement of a material fact or to omit to state a material fact necessary in order to make the statements made, in the light of the circumstances under which they were made, not misleading."[19] In addition to being false and material, the action or omission giving rise to a Rule 10b-5 violation must also be made with the statutorily required state of mind, and the false statement at issue must generate detrimental reliance—the kind of reliance that leads to tangible loss.[20] The objective in passing Rule 10b-5 was to extend the SEC's regulatory power to postoffering transactions, although there is again no evidence of a desire to expand the scope of the rule to private civil remedies.[21]

Despite a lack of explicit congressional or administrative intent, federal courts began inferring a private right of action under Rule 10b-5 in 1946.[22] Later, in the influential Second Circuit decision *SEC v. Texas Gulf Sulphur Co.*, the court categorically abandoned a privity requirement, allowing private actors to sue a corporation for damages suffered as a result of third-party

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16. Securities Exchange Act of 1934 § 10(b), 15 U.S.C. § 78(j).

17. Joseph A. Grundfest, *Damages and Reliance Under Section 10(b) of the Exchange Act*, 69 BUS. LAW. 307, 321 (2014).

18. *Id.* at 321 & n.66 (quoting Stoneridge Inv. Partners, LLC v. Scientific-Atlanta, Inc., 552 U.S. 148, 157 (2008)).

19. 17 C.F.R. § 240.10b-5 (2015).

20. *See* Padfield, *supra* note 12, at 932.

21. Grundfest, *supra* note 17, at 312. Although this appears to be true at the time of passage, some have noted that the landmark opinion codifying the fraud-on-the-market doctrine, which removed the need to prove individual reliance in class actions, under Rule 10b-5, *Basic Inc. v. Levinson*, 485 U.S. 224 (1988), was itself largely authored by the SEC in conjunction with the Solicitor General's office. The key analytical points regarding materiality and reliance appear to have been taken directly from an amicus brief filed on behalf of the SEC. Donald C. Langevoort, Basic *at Twenty: Rethinking Fraud on the Market*, 2009 WIS. L. REV. 151, 157.

22. Grundfest, *supra* note 17, at 322. As discussed by the Supreme Court in *Herman & MacLean v. Huddleston*, 459 U.S. 375, 380 n.10 (1983), the first case incorporating the implied right of action was *Kardon v. National Gypsum Co.*, 69 F. Supp. 512, 513-14 (E.D. Pa. 1946). *See also* Grundfest, *supra* note 17, at 322 n.75.

transactions.[23] Over subsequent decades, judicial acceptance of an implied private right of action spread across jurisdictions and was ultimately upheld by the Supreme Court in *Herman & MacLean v. Huddleston*.[24] Justice Marshall, writing for the majority, acquiesced to federal judicial practice, while noting that the Securities Act and the Exchange Act had overtly created other private actions while failing to do so here. Having been consistently recognized for over thirty-five years, the existence of an implied right of action was now "simply beyond peradventure."[25] The Court was similarly persuaded that given the opportunity to clarify congressional intent while enacting significant revisions to the nation's securities laws in 1975, Congress tacitly registered its approval of a private right of action under section 10(b).[26]

Initially, the burden of proof for actions brought under section 10(b) mirrored that of common law deceit.[27] To recover money damages, plaintiffs had to demonstrate materiality (that the misstatement or omission was in fact relevant to a rational investor), scienter (an intent to deceive on behalf of the organization or its agent), reliance (inducement to trade as a result of the misstatement or omission), and loss causation (that the misstatement or omission constituted the proximate cause of the complaining party's injuries).[28] However, structural limitations in adapting the common law standard made the consolidation of securities fraud claims unworkable. Each individual plaintiff's damage amount was unlikely to be large enough to justify the litigation expenses associated with a civil trial. It would also be unduly burdensome to require each plaintiff to prove direct reliance on the purportedly fraudulent misstatement. To create a practical standard for consolidating suits, courts looked to the burgeoning academic consensus of "market efficiency" within the field of financial economics regarding the rationality of financial markets.

B. Market Efficiency, "Fraud-on-the-Market," and *Basic Inc. v. Levinson*

Although many commentators consider the Supreme Court's decision in *Basic Inc. v. Levinson*[29] to have ushered in the prevailing standard for securities fraud class actions, *Basic* did not actually represent a marked departure from

23. 401 F.2d 833, 861 (2d Cir. 1968) (en banc).
24. 459 U.S. 375.
25. *Id.* at 380.
26. *Id.* at 384-86.
27. *See* Dunbar & Heller, *supra* note 14, at 458.
28. *Id.*
29. 485 U.S. 224 (1988).

prior judicial practice.[30] From the outset, the judiciary recognized that it would be functionally impossible to require plaintiffs to demonstrate individual reliance.[31] While courts had expressed a general preference for a presumption of individual reliance, a coherent framework for minimizing the reliance burden on plaintiffs would allow class action treatment of Rule 10b-5 violations to continue as established practice.[32] Perhaps surprisingly, such a theory was found within the conservative law and economics movement, which advocated for applying the principles of the theory of capital market efficiency—that all available public information reflecting the firm's prospects are reflected in the prevailing price of the security—to the standards of materiality and reliance embedded in Rule 10b-5.[33]

The efficient market hypothesis began as a scholarly attempt to answer a question that had long bedeviled individual investors: Is it possible to systematically beat the market? Beginning with seminal articles written by future Nobel Laureates Paul Samuelson and Eugene Fama in the 1960s, many economists were persuaded that asset prices on liquid markets fluctuated randomly.[34] In practical terms, this meant that the daily price changes of large common stocks were unpredictable, rendering it impossible for investors to achieve above-average returns without a willingness to take on higher risk.[35] Although some scholars registered skepticism with the hypothesis, the general

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30. *See* Jill E. Fisch, *The Trouble with* Basic*: Price Distortion After* Halliburton, 90 WASH. U. L. REV. 895, 900 (2013).

31. *Id.* at 900 & n.27.

32. *See* Rosemary J. Thomas, Note, *The Fraud-on-the-Market Theory: A "Basic"ally Good Idea Whose Time Has Arrived,* Basic, Inc. v. Levinson, 22 IND. L. REV. 1061, 1063 (1989) (claiming that the fraud-on-the-market presumption endorsed in *Basic* "serves as an entree for plaintiff class actions" by removing a burdensome procedural hurdle).

33. *See* Langevoort, *supra* note 21, at 154.

34. Eugene F. Fama, *The Behavior of Stock-Market Prices,* 38 J. BUS. 34 (1965); Paul A. Samuelson, *Proof that Properly Anticipated Prices Fluctuate Randomly,* INDUS. MGMT. REV., Spring 1965, at 41. Although these articles are generally viewed as the intellectual precursors to the efficient capital markets hypothesis, a similar observation was in fact made by the French mathematician Louis Bachelier in 1900. Edward J. Sullivan & Timothy M. Weithers, *Louis Bachelier: The Father of Modern Option Pricing Theory,* 22 J. ECON. EDUC. 165, 166 (1991). For an interesting review of the intellectual history of the doctrine and its connection to the debate surrounding the theory's role in the recent financial crisis, see JUSTIN FOX, THE MYTH OF THE RATIONAL MARKET: A HISTORY OF RISK, REWARD, AND DELUSION ON WALL STREET (2d ed. 2010).

35. *See* Burton G. Malkiel, *The Efficient Market Hypothesis and Its Critics,* J. ECON. PERSP., Winter 2003, at 59, 59-60 (noting that efficient markets are associated with returns "where all subsequent price changes represent random departures from previous prices" and "do not allow investors to earn above-average returns without accepting above-average risks").

consensus remained that markets approached efficiency.[36] In recent years, the field of behavioral finance—arguing instead that recognized psychological biases often lead to systematic mispricing of financial instruments—has amassed growing appeal but has yet to have a corresponding effect on judicial opinion.[37]

Adherents to the efficient market hypothesis saw an opportunity for theory to ameliorate the inherent legal ambiguities associated with securities fraud cases. If one takes the position that prices reflect all publicly available information, then questions of individual reliance become irrelevant. As Dan Fischel, a leading conservative law and economics scholar and adherent to this view, wrote in an influential 1982 article in the *Business Lawyer*, "Because all publicly available information is embedded in stock prices, investors who accept the market price are fully protected."[38] When stocks are priced to accurately reflect all public information, individual investors have little incentive to seek out private information. Instead of protecting individual investors, "[t]he law should protect markets: markets will then protect investors."[39] In fact, according to Fischel, the reliance requirement should have been removed from securities fraud doctrine in its entirety:

> Because the rational course for investors is simply to accept (rely on) the market price, it is of no consequence whether a plaintiff can demonstrate that he relied upon a particular piece of information. If fraudulent conduct caused the market price to be artificially high or low, a plaintiff under the market model has been injured even if he was totally unaware of the challenged conduct.[40]

Rather than totally abandoning the reliance requirement, courts have embraced insights from the law and economics movement to develop an alternative scheme through which plaintiffs can avoid subjective determinations of individual reliance.[41] This "fraud-on-the-market" (FOTM) theory posits that defendants distort their stock price through the use of deceptive misstatements or omissions, effectively inducing the plaintiff's

36. *See* Daniel R. Fischel, *Use of Modern Finance Theory in Securities Fraud Cases Involving Actively Traded Securities*, 38 BUS. LAW. 1, 4 n.9 (1982).

37. In *Amgen Inc. v. Connecticut Retirement Plans & Trust Funds*, a cryptic concurrence by Justice Alito signaled that the Court may be willing to rethink its adherence to a "faulty economic premise." 133 S. Ct. 1184, 1204 (2013) (Alito, J., concurring). However, in the recent installment of *Halliburton Co. v. Erica P. John Fund, Inc.* (*Halliburton II*), the Court decided against overturning the *Basic* presumption on market efficiency grounds, leaving the doctrine's acceptance of its principles in place. 134 S. Ct. 2398, 2406-10 (2014).

38. Fischel, *supra* note 36, at 5.

39. Langevoort, *supra* note 21, at 165.

40. Fischel, *supra* note 36, at 8.

41. *See* Fisch, *supra* note 30, at 907.

reliance.[42] The FOTM theory was first adopted by the District Court for the Southern District of New York in 1969[43] and by the Ninth Circuit Court of Appeals in 1975.[44] By the time *Basic* came before the Supreme Court, "all courts of appeals that had considered the question had invoked some kind of reliance presumption in order to make fraud-on-the-market class-action lawsuits certifiable."[45]

While *Basic* also set the prevailing judicial standard for materiality, the "more profound and more enigmatic" determination made by the Court involved reliance and the FOTM theory.[46] In a 4-2 ruling, the majority rejected the argument that the FOTM doctrine eliminated the reliance requirement, claiming instead that "[r]eliance provides the requisite causal connection between a defendant's misrepresentation and a plaintiff's injury."[47] Citing recent empirical studies, the Court declared that the price of a security traded on a well-developed market "reflects all publicly available information" and found a presumption of reliance to be "supported by common sense and probability."[48] An investor purchasing shares "does so in reliance on the integrity of that [market] price," and as such, reliance on the purported material misrepresentations could be presumed under Rule 10b-5.[49]

C. Post-*Basic* Case Law and the Structure of the FOTM Class Action

Following the ruling in *Basic*, the modern structure of a Rule 10b-5 securities class action took shape. To establish the presumption of reliance, plaintiffs would ultimately be required to demonstrate both that the affected security traded in an "efficient market"[50] and that the misrepresented or

42. *Id.*
43. *See* Herbst v. Able, 47 F.R.D. 11, 16 (S.D.N.Y 1969).
44. *See* Blackie v. Barrack, 524 F.2d 891, 906 (9th Cir. 1975).
45. Langevoort, *supra* note 21, at 153.
46. *Id.*
47. Basic Inc. v. Levinson, 485 U.S. 224, 243 (1988).
48. *Id.* at 246.
49. *Id.* at 247.
50. Although this could seemingly be read to indicate that the *exchange* on which the security traded needed to be characterized as open or developed, *see id.* ("[N]early every court that has considered the proposition has concluded that where materially misleading statements have been disseminated into an impersonal, *well-developed market for securities*, the reliance of individual plaintiffs . . . may be presumed." (emphasis added)), courts instead adopted a standard affirming that the market for the *individual security* from which the suit was derived needs to be characterized as efficient, *see, e.g.*, Cammer v. Bloom, 711 F. Supp. 1264, 1277 (D.N.J. 1989).

omitted information was material.[51] Additionally, there must be an established causal link between the purported misrepresentations and the plaintiff's ultimate loss[52] and a proper calculation of classwide damages upon positive disposition on the merits.[53] Each of these factual determinations would become empirical prerequisites, requiring the provision of expert testimony and econometric analysis.

1. Market efficiency

Although *Basic* states that market efficiency is a precondition for the reliance presumption, the Court did not specify how "efficient" the market must be or the manner in which market efficiency could be tested.[54] The concept of efficiency, intrinsically connected to the theory underlying the FOTM doctrine, had been discussed in precedent but rarely applied rigorously.[55] Although this inquiry would appear ripe for Supreme Court guidance, it was ultimately left to lower courts to establish a workable standard for determining whether the market for a security was efficient enough to establish the reliance presumption.

The most influential standard adopted in testing market efficiency was articulated in *Cammer v. Bloom*,[56] decided in New Jersey's district court shortly after *Basic*. The court created a list of conditions (today colloquially known as the "*Cammer* factors"[57]) to guide the determination of whether the market for a particular stock is legally efficient.[58] These factors include the weekly trading volume,[59] the presence of "a significant number of securities analysts"

51. *See* Grundfest, *supra* note 17, at 327. Grundfest notes that, although this presumption is nominally rebuttable, it is effectively unrebuttable in practice. At the time of writing, he was able to identify only six instances in which defendants rebutted the presumption of reliance. *Id.* at 388.

52. *See* Fisch, *supra* note 30, at 914.

53. Miller v. Asensio & Co., 364 F.3d 223, 235 (4th Cir. 2004) (holding that compensable damages must be independently proven even where liability has been established).

54. *See* Langevoort, *supra* note 21, at 166.

55. *See* Barbara Black, *The Strange Case of Fraud on the Market: A Label in Search of a Theory*, 52 ALB. L. REV. 923, 937 (1988).

56. 711 F. Supp. 1264 (D.N.J. 1989).

57. *See, e.g.*, Bradford Cornell, *Market Efficiency and Securities Litigation: Implications of the Appellate Decision in* Thane, 6 VA. L. & BUS. REV. 237, 245-46 (2011).

58. Although there are variants of market efficiency proposed in the financial economics literature, courts have adopted the semi-strong form of market efficiency, which stipulates that the price of the security incorporates all available public information. *See* Daniel R. Fischel, *Efficient Capital Markets, the Crash, and the Fraud on the Market Theory*, 74 CORNELL L. REV. 907, 911 (1989).

59. *Cammer*, 711 F. Supp. at 1286. Citing to a securities treatise, the court noted that total weekly trading turnover of at least two percent would be indicative of a security

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following and reporting on the company's financial position,[60] the existence and number of market makers and arbitrageurs,[61] an entitlement to file an S-3 registration statement with the SEC,[62] and empirical evidence of a cause-and-effect relationship between unexpected corporate events and movements in the price of the security.[63] Some courts have added additional elements to the test, including the market capitalization of the security, the bid-ask spread, the percentage of stock held by insiders, and the presence of institutional investors trading in the security.[64]

The ability of any of these judicially constructed proxies to reveal the degree of efficiency in a security has been called into question from the outset. Bradford Cornell and James C. Rutten note that only the number of analysts following a stock and the cause-and-effect relationship between news and price "directly speak to whether a market is efficient."[65] The remaining factors are better seen as indicia of efficiency; they may correlate with the notion of market efficiency as understood by financial economists, but in isolation they do not influence the mechanism through which the price of a stock comes to reflect its fundamental value. Courts have consequently treated the fifth *Cammer* factor, a cause-and-effect relationship between unexpected corporate events and the movement in asset price, as the primary test of efficiency.[66] As

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trading in an efficient market. *Id.* (citing 4 ALAN R. BROMBERG & LEWIS D. LOWENFELS, BROMBERG AND LOWENFELS ON SECURITIES FRAUD & COMMODITIES FRAUD § 8.6 (2d ed. 1988)).

60. *Id.* The court hypothesized that the presence of securities analysts would create more accurate pricing of the security as the "stock would be bid up or down to reflect the financial information contained in [financial] reports." *Id.*

61. *Id.* The presence of market makers, who "react swiftly to company news and reported financial results," would "ensure completion of the market mechanism." *Id.* at 1286-87.

62. *Id.* at 1287. The court's reasoning here has more to do with the size of the market for the security than any procedural impact the SEC filing may have. Thus, this requirement may be satisfied if the ineligibility to file an S-3 was solely a result of "timing factors." *Id.* The court here presumes that the number and value of shares outstanding "imply efficiency." *Id.*

63. *Id.*

64. William O. Fisher, *Does the Efficient Market Theory Help Us Do Justice in a Time of Madness?*, 54 EMORY L.J. 843, 862 (2005).

65. Bradford Cornell & James C. Rutten, *Market Efficiency, Crashes, and Securities Litigation*, 81 TUL. L. REV. 443, 454 (2006).

66. *In re* Winstar Commc'ns Sec. Litig., 290 F.R.D. 437, 448 (S.D.N.Y. 2013) ("The fifth *Cammer* factor that courts consider is whether the Plaintiff can demonstrate empirical facts that show 'a cause and effect relationship between unexpected corporate events or financial releases and an immediate response in the [security's] price.' Courts have considered this 'the most important *Cammer* factor' because without finding this causal relationship, it is 'difficult to presume that the market will integrate the release of material information about a security into its price.'" (alteration in original) (citations

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the *Cammer* court observed, "This, after all, is the essence of an efficient market and the foundation for the fraud on the market theory."[67]

Some academics and practitioners have called for removing the efficiency requirement from the FOTM doctrine.[68] Others maintain that efficiency is still a necessary predicate for a presumption of reliance,[69] particularly when viewed in conjunction with the theory of damages.[70] Regardless of academic dispute, the judiciary still considers market efficiency to be a certification requirement. In 2005, the First Circuit grappled with this issue in *In re Polymedica Corp. Securities Litigation*.[71] Although acknowledging the unsettled nature of the case law, *Polymedica* held that the market for the company's stock has to be one "in which the market price of the stock *fully reflects all* publicly

omitted) (first quoting *Cammer*, 711 F. Supp. at 1287; then quoting Teamsters Local 445 Freight Div. Pension Fund v. Bombardier Inc., 546 F.3d 196, 207 (2d Cir. 2008))).

67. *Cammer*, 711 F. Supp. at 1287.

68. *See, e.g.*, Langevoort, *supra* note 21, at 176 ("If *Basic*'s presumption is essentially an entitlement to rely on the market price as undistorted by fraud, it is hard to see why investors should lose that entitlement simply because of some market imperfection."); Jonathan R. Macey et al., *Lessons from Financial Economics: Materiality, Reliance, and Extending the Reach of* Basic v. Levinson, 77 VA. L. REV. 1017, 1018 (1991) ("Though restricting fraud-on-the-market theory to efficient markets is intuitively appealing[,] . . . we believe this distinction between efficient and inefficient markets to be specious. We suggest that the focus of the Supreme Court's holding in *Basic* is misplaced: what determines whether investors were justified in relying on the integrity of the market price is not the efficiency of the relevant market but rather whether a misstatement distorted the price of the affected security.").

69. *See, e.g.*, Dunbar & Heller, *supra* note 14, at 532 ("If one accepts that certain actively-traded securities at certain times do not obey the rules of an efficient market and, as a result, investors may not rely on the price to fully reflect publicly available information, then it is difficult to understand why the presumption of reliance should not be rejected just as it is for illiquid securities that do not obey the rules of an efficient market. Failing to reject the presumption of reliance in such a case would be tantamount to changing the fraud-on-the-market theory from a presumption to removing plaintiffs' burden of proving reliance altogether. This would make *Basic* unintelligible because the Court left open the possibility that reliance could be disproved; a position that at this time does not seem to have adverse policy consequences.").

70. *See, e.g.*, Cornell & Rutten, *supra* note 65, at 449 ("[I]n the damages context, we argue for a much stricter standard for efficiency that is again tied to the fundamental issue. . . . Damages cannot accurately be measured by reference to the decline in the stock price unless the market is *perfectly* efficient such that it reacts *perfectly* to fraudulent statements and the later revelation of true facts. . . . Although damages in securities fraud cases, as in other types of cases, need not be measured accurately and only approximated, even approximating damages by reference to the decline in the stock price would require the market to approximate perfect efficiency because even minor inefficiencies are magnified significantly by selection bias." (footnote omitted)).

71. 432 F.3d 1 (1st Cir. 2005).

available information" for the presumption to apply.[72] More recently, many believed that the Supreme Court's conservative leaning would result in a radical restructuring of the class action device.[73] However, in *Halliburton II* the Court refused to jettison the efficiency requirement, but did clarify that the standard should be generalized efficiency.[74] It would appear as though the efficient market requirement will remain while the FOTM theory is in place.

2. Materiality, price distortion, and loss causation

In addition to the presumption of reliance, plaintiffs bear the burden of demonstrating that the alleged misstatements or omissions were material to the average investor. In *Basic*, the Supreme Court unanimously[75] affirmed the position on materiality previously established in *TSC Industries, Inc. v. Northway, Inc.*: in order to fulfill the materiality requirement, "there must be a substantial likelihood that the disclosure of the omitted fact would have been viewed by the reasonable investor as having significantly altered the 'total mix' of information made available."[76] The Court refused to follow the lower court standard that based the materiality determination on policy factors, such as the protection of corporate secrets.[77] Instead, the Court held the materiality inquiry should involve a fact-specific analysis of whether a reasonable investor would hold the particular alleged misrepresentation or omission to be significant in the context of the information available to the market.[78] Much like the requirement for market efficiency, this standard proved long on rhetoric but short on practical application.

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72. *Id.* at 14.

73. *See, e.g.*, Grundfest, *supra* note 17, at 310; *see also* Paul Atkins, *The Supreme Court's Opportunity to End Abusive Class Action Securities Lawsuits*, FORBES (Mar. 4, 2014, 3:57 PM), http://www.forbes.com/sites/realspin/2014/03/04/the-supreme-courts-opportunity-to-end-abusive-securities-class-action-lawsuits (calling for the Supreme Court to "clear the judicial underbrush surrounding securities class action suits" that *Basic* caused).

74. *Halliburton II*, 134 S. Ct. 2398, 2410 (2014). Donald Langevoort believes that this focus on generalized efficiency may remove much of the pressure to analyze market efficiency at the class certification stage. *See* Donald C. Langevoort, *Judgment Day for Fraud-on-the-Market: Reflections on* Amgen *and the Second Coming of* Halliburton, 57 ARIZ. L. REV. 37, 52-53 (2015).

75. Although this was a unanimous decision, the bench was not full. Justice Powell had retired a few months after certiorari was granted, and his successor, Justice Kennedy, had yet to be sworn in. Chief Justice Rehnquist and Justice Scalia had also recused themselves. Langevoort, *supra* note 21, at 157.

76. Basic Inc. v. Levinson, 485 U.S. 224, 231-32 (1988) (quoting TSC Indus., Inc. v. Northway, Inc., 426 U.S. 438, 449 (1976)).

77. Langevoort, *supra* note 21, at 152.

78. *Basic*, 485 U.S. at 240.

Law and economics scholars saw an opportunity for the efficient market hypothesis to categorically determine materiality. Notably skeptical of a factfinder's ability to discern the particular significance of an information set to the average investor, scholars proposed allowing the market to make the determination. According to Fischel, "The primary advantage of the market model is that it recognizes that the question of what information is important to investors cannot be answered in the abstract."[79] Materiality should be determined solely on the basis of whether "the alleged misrepresentation or disclosure caused the security to trade at an artificially high or low price."[80]

As with reliance, courts have been receptive to this interpretation of the legal standard.[81] In *In re Merck & Co. Securities Litigation*, the Third Circuit stated that materiality "may be measured post hoc" by looking at the movement of the stock price in the period immediately after the disclosure of information.[82] This mode of reasoning was in fact "part of a larger agenda" within the conservative law and economics movement to supplant subjective evaluations of materiality with an impartial market-based standard.[83] It was the promise of inherent objectivity and a "rigorous, unified, empirical approach to materiality, reliance, and causation" through empirical econometric methods that made the FOTM theory appealing in the first instance.[84]

Those scholars advocating for the removal of a market efficiency requirement also premised their belief on the notion that "price distortion" was sufficient to establish that the plaintiff was harmed through a material

79. Fischel, *supra* note 36, at 7.

80. *Id.*

81. Although materiality is an undisputed element of a Rule 10b-5 class action, the Supreme Court has grappled with whether it needs to be established before a class can be certified. In *Amgen Inc. v. Connecticut Retirement Plans & Trust Funds*, 133 S. Ct. 1184, 1191 (2013), the Court held that materiality was not an inquiry that touched on issues of classwide proof and was more appropriately dealt with at the merits stage. About a year later in *Halliburton II* the Court held that, although materiality does not *need* to be established for the class to be certified, defendants can present evidence rebutting the materiality of alleged misrepresentations based on a price impact analysis, seemingly shifting the burden of proof for materiality from the plaintiffs to the defendants in exchange for an expedited review. 134 S. Ct. 2398, 2417 (2014). It is presently unclear what effect this will have on class certification judgments going forward. *See, e.g.*, Merritt B. Fox, *Halliburton II: What It's All About*, 1 J. FIN. REG. 135, 142 (2015).

82. 432 F.3d 261, 269 (3d Cir. 2005) (quoting Oran v. Stafford, 226 F.3d 275, 282 (3d Cir. 2000)).

83. Langevoort, *supra* note 21, at 179.

84. Langevoort, *supra* note 74, at 44 (footnote omitted). In addition to Fischel, *supra* note 36, Langevoort also cites Roger J. Dennis, *Materiality and the Efficient Capital Market Model: A Recipe for the Total Mix*, 25 WM. & MARY L. REV. 373 (1984), as having a significant effect on the holding in *Basic*. Langevoort, *supra* note 74, at 44 nn.39-40.

misrepresentation.[85] Believing that courts were best served focusing on whether the public misstatement was reflected in the market price, these scholars asserted that materiality should be found "[w]henever event study methodology shows that a fraudulent event has had a *statistically significant* effect on the price of a firm's securit[y]."[86] This view presupposed the ease with which courts could analyze the empirical evidence of a stock price reaction to the release of information.

However, "the simplicity was an illusion."[87] Econometric analyses of changes in the price of a security, particularly when conducted by dueling economic experts paid by adversarial parties to a lawsuit, produced entirely divergent results as the rule and not the exception.[88] In his precursor article to *Basic*, Fischel made a bold prediction that likely assuaged the concerns of those Justices hesitant to uphold the FOTM doctrine:

> Moreover, resources spent on securities fraud litigation will be reduced. Because the focal issue of every case will be whether there has been any effect on the market price of the firm's securities, the increased certainty resulting from this objective determination will reduce the amount of litigation. On those occasions when litigation is brought, there will no longer be any need for fact-finding on such issues as what a reasonable investor would have thought important or whether investors were aware of a certain document. *In all probability, therefore, the effect on the market price approach will decrease the overall amount of litigation under rule 10b-5.*[89]

This prediction proved staggeringly inaccurate. Instead of imposing discipline on subjective judicial discretion, Rule 10b-5 claims brought under the FOTM doctrine turned out to be a boon to the securities litigation industry. By 1991, just three years after the ruling in *Basic*, the number of securities class action filings had tripled, and they continued to rise over the following decades.[90] Joseph Grundfest, writing before the portentous second decision in *Halliburton*, noted that securities fraud had become veritable big business. Between 1997 and 2013 over three thousand cases were filed, generating settlements of over $73 billion and "compris[ing] six of the ten largest settlements in class action history."[91]

85. *See, e.g.*, Macey et al., *supra* note 68, at 1018.

86. *Id.*

87. Langevoort, *supra* note 74, at 44.

88. *See* Langevoort, *supra* note 21, at 179.

89. Fischel, *supra* note 36, at 16 (emphasis added).

90. Langevoort, *supra* note 21, at 179.

91. Grundfest, *supra* note 17, at 308. The article further details how, between 1997 and 2013, plaintiffs' lawyers earned more than $14 billion in fees with defense counsel likely earning something comparable. *Id.* at 309. This represents both a private and public burden; in the years 2002 to 2004, class action securities cases represented nearly half of all class action cases pending in federal court. *Id.*

In response to perceived abuses, including the mechanical filing of lawsuits following price declines, abuse of the discovery rules "with only faint hope that the discovery process might lead eventually to some plausible cause of action,"[92] and improper solicitation of class representatives by plaintiffs' attorneys, Congress passed the Private Securities Litigation Reform Act of 1995 (PSLRA).[93] The PSLRA enacted various procedural safeguards to reduce frivolous lawsuits, many of which addressed the conduct of plaintiffs' attorneys.[94] In addition to these general procedural safeguards, the PSLRA changed substantive pleading requirements for cases brought under Rule 10b-5. Following the enactment of the PSLRA, it was no longer sufficient to simply establish materiality and market efficiency; a moving party was required to demonstrate "loss causation," a statutorily undefined concept.[95]

The Court ultimately provided clarity in *Dura Pharmaceuticals, Inc. v. Broudo*, holding that loss causation signified the plaintiff's burden to establish a direct causal nexus between the defendant's fraud and the economic harm.[96] *Dura* categorically rejected the notion that reliance and loss causation are synonymous concepts, holding instead that both must be established separately.[97] Economic injury would be measured at two different points in time—when the stock was purchased and when the fraudulent misstatement was ultimately disclosed to the market.[98] Viewed in conjunction with the reliance requirement from *Basic*, *Dura* stands for the proposition that "the plaintiff's economic loss is the amount of the original price distortion that remains in the stock until the corrective disclosure, as measured by the market's response to the disclosure of the original misrepresentation."[99] Unsurprisingly, the response by courts to this heightened standard has been "by all accounts a doctrinal and practical mess."[100]

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92. H.R. REP. NO. 104-369, at 31 (1995) (Conf. Rep.).
93. Pub. L. No. 104-67, 109 Stat. 737 (1995) (codified as amended in scattered sections of 15 U.S.C.).
94. Gregory Kendall, Comment, *The Artful Dodgers: Securities Fraud, Artful Pleading, and Preemption of State Law Causes of Action Under the Securities Litigation Uniform Standards Act*, 81 U. CIN. L. REV. 657, 660 (2012).
95. Fisch, *supra* note 30, at 914.
96. *See* 544 U.S. 336, 345-46 (2005); Fisch, *supra* note 30, at 915.
97. *Dura*, 544 U.S. at 346; *see also* Fisch, *supra* note 30, at 915.
98. Fisch, *supra* note 30, at 915. Under the logic of *Dura*, a plaintiff who purchased an overvalued share but who is able to offload the share before the market discovered the fraud suffered no injury. Any decrease in the price over this period resulted from factors unrelated to the fraud. *Id.*
99. *Id.*
100. Langevoort, *supra* note 74, at 45.

3. Damages

A remaining practical concern, and one which figures prominently in any discussion of securities litigation practice, pertains to the calculation of damages. In none of its twenty-eight opinions interpreting the scope of section 10(b) class actions has the Supreme Court opined on the question of after-market damages.[101] Lacking explicit guidance, most lower courts have adopted the "out-of-pocket" damages[102] standard set forth in *Affiliated Ute Citizens v. United States*.[103] Under *Affiliated Ute*, each purchaser of a security is entitled to the difference between the price paid for the security and the price it would have traded at had there been no fraudulent misrepresentation or omission.[104] In addition to the inherent difficulties of determining the "but-for" trading price (generally done through the use of an event study, as described in Part III below), an aggregate damage calculation is contingent on an estimation of the precise number of shares entitled to recovery and statistical adjustments for the frequency with which shares changed hands.[105] Although some courts were under the impression that computing individual damages would be "virtually a mechanical task,"[106] these determinations require complicated statistical calculations that courts and finders of fact are largely unqualified to evaluate.

Against this backdrop of complexity, it is all the more disconcerting that the Supreme Court has yet to provide clarity. As Grundfest notes, "[T]his entire statistical methodology governing a multi-billion dollar litigation market, in which subtle differences in econometric technique can have significant impact on plaintiff recoveries and defendant exposures, has evolved without any Supreme Court oversight."[107] One reason for the dearth of judicial influence on the subject is certainly the overall infrequency with which cases proceed to trial. Given the immense liability attached to securities class actions, the potential inability of the jury to understand complex econometric disputes, and the high cost of litigation, settlement pressure is immense. Since Congress

101. Grundfest, *supra* note 17, at 310.

102. *Id.* at 364-65.

103. *See* 406 U.S. 128, 155 (1972).

104. Janet Cooper Alexander, *The Value of Bad News in Securities Class Actions*, 41 UCLA L. REV. 1421, 1428-29 (1994).

105. *Id.* at 1432. Alexander notes that "the trades of 'ins-and-outs' must be estimated through a statistical model. Building such a model depends on an assumption about the statistical probability that any particular share will trade on a given day." *Id.* at 1459. Alexander further posits that the model most commonly used by plaintiffs, the proportional trading model, assumes that there is an equal chance of trading for each share and may inflate the total class damage amount by one hundred percent or more. *Id.* at 1459-60, 1462.

106. Blackie v. Barrack, 524 F.2d 891, 905 (9th Cir. 1975).

107. Grundfest, *supra* note 17, at 365.

passed the PSLRA, only twenty cases have gone to trial, and only fourteen of those reached a verdict.[108] However, even if settlement pressure induces parties to resolve disputes privately, it does not follow that judicial practice is best served by allowing parties to resolve damage disputes among themselves.

Janet Cooper Alexander notes that the issue of computing damages may actually be *more* consequential when a case is settled out of court.[109] Whereas trials devote significant attention to addressing liability, settlement discussions are largely centered on the amount of compensation.[110] When overall uncertainty exists surrounding the proper method of computing damages, settlement discussions "may be impeded or distorted."[111] Even with general agreement regarding the proper model of damages, calculations made by opposing parties are often orders of magnitude apart. The lack of established judicial precedent leaves the parties uninformed on implementing a standard for measuring damages and constructing favorable negotiating positions anchored to this standard.[112] In the absence of Supreme Court guidance, the parties and their respective expert witnesses act with minimal supervision in crafting damage calculations used for settlement, with distortionary impacts on private adjudication.

In sum, as a result of decades of federal court adjudication, more than two dozen Supreme Court decisions, and intermittent legislative guidance, the standard for a private right of action under section 10(b) now contains a number of discrete requirements in addition to traditional common law standards. Plaintiffs must establish that the market for the security in question is semi-strong form efficient, normally through the use of the *Cammer* factors, to obtain the presumption of reliance established in *Basic*. Additionally, they are required to demonstrate that the purportedly false and misleading statements changed the "total mix" of information available to the market and that the misrepresentation had a direct causal connection to their ultimate claim of harm, both of which are now largely empirical determinations. Finally, after establishing liability, plaintiffs must put forward a defensible

108. RENZO COMOLLI & SVETLANA STARYKH, NERA ECON. CONSULTING, RECENT TRENDS IN SECURITIES CLASS ACTION LITIGATION: 2013 FULL-YEAR REVIEW 36 (2014), http://www.nera.com/content/dam/nera/publications/2014/PUB_Year_End_Trends_1.2014.pdf.

109. Alexander, *supra* note 104, at 1422.

110. *Id.*

111. *Id.* at 1423. Alexander notes that with divergent damage estimates, parties may find it hard to reach a "zone of agreement" in which a settlement can occur. *Id.* These differences will compound the "psychological barriers" that already impede the efficient resolution of a negotiation. *Id.*

112. *Id.* at 1424.

calculation of classwide damages through the use of an event study and statistical estimates of trading activity.

II. Role of Expert Testimony in Securities Fraud Litigation

Following the doctrinal shift from traditional standards of materiality and reliance to a market-oriented norm, expert testimony took on added significance. As described in the preceding Part, there are four objective areas of dispute in the prosecution of class action lawsuits under Rule 10b-5: reliance, materiality, loss causation, and damages. Each of these considerations is critically dependent on the provision of a reliable event study by a qualified expert.[113]

An event study is a statistical analysis of the effect of an "event" on the price of a security. Determinations are made by comparing the actual return to the return predicted by the contemporaneous change in a benchmark index of comparable stocks and the security's historical comovement with the market.[114] At the time the FOTM doctrine was established, it was generally assumed that event studies were robust to methodological choice.[115] More recent scholarship, however, has recognized the inherent ambiguity and challenges associated with event study design.[116]

A. Overview of an Event Study

The event study is a tool appropriated from the financial economics literature, in which it is commonly used to assess the impact of a general type of event over a large cross-section of securities.[117] The use of event studies in litigation is appealing because, in an efficient market, the price of a security will immediately reflect the effect of an event.[118] Courts have consequently

113. *See* Kaufman & Wunderlich, *supra* note 1, at 187.

114. *See* Alexander, *supra* note 104, at 1433.

115. *See, e.g.*, Macey et al., *supra* note 68, at 1030 ("[R]esearchers have shown that the findings of event studies using different methodologies are robust in a wide variety of situations. That the findings of event studies using any of a number of methodologies are very similar is especially true when testing for materiality in a fraud-on-the-market theory case—the effect on stock returns of an important piece of news released over a short period of time." (footnote omitted)).

116. *See, e.g.*, Fisch, *supra* note 30, at 919 ("Although event studies are used extensively, they are imperfect tools for measuring the effect of a disclosure on stock prices. . . . [T]heir application presents a number of methodological challenges.").

117. *See, e.g.*, Eugene F. Fama et al., *The Adjustment of Stock Prices to New Information*, 10 INT'L ECON. REV. 1, 3 (1969).

118. A. Craig MacKinlay, *Event Studies in Economics and Finance*, 35 J. ECON. LITERATURE 13, 13 (1997).

used event studies to analyze a range of disputes, including mergers and acquisitions, earnings announcements, issuance of debt and equity securities, and the effect of regulatory changes.[119] Their ubiquity in litigation has led some to declare that, "[a]s large a role as event studies play in empirical financial economics and policy analysis, their importance in litigation (e.g., under SEC Rule 10b-5), may be even greater."[120] However, while many of the statistical assumptions inherent to event studies are of minor concern when applied across time and across securities, their significance is magnified when applied to one security for only a select number of events.[121]

Although there is considerable academic debate regarding the statistical methodology used in event studies, the "general flow of analysis" is reasonably established.[122] There are three practical conditions necessary to properly conduct a useful event study: (1) a return series covering the event at issue is available, (2) the stock trades frequently enough for each return to cover only one day (or at most a few days), and (3) the parties can confidently establish the dates on which the event in question occurred.[123] Once established, there are three basic facets of conducting an event study: (1) defining the "event window," (2) calculating the abnormal returns of the stock over the event window, and (3) testing for statistical significance of the abnormal return.[124]

The event window is the period over which the effect of the event on the security will be analyzed. Because event studies are premised on the efficient market hypothesis, the presumption is that the stock price will quickly reflect new information when released to the market. Consequently, event windows used for litigation are typically quite short and may cover only the one-day trading period following the event.[125] If the exact time that the information was released to the market is uncertain, or if the analyst has reason to believe that the information was not quickly absorbed into the stock price, courts may allow for longer event windows.[126] However, a longer event window can

119. *Id.*

120. Jonah B. Gelbach et al., *Valid Inference in Single-Firm, Single-Event Studies*, 15 AM. L. & ECON. REV. 495, 499 (2013).

121. *See* Fisch, *supra* note 30, at 920.

122. MacKinlay, *supra* note 118, at 14.

123. *See* M. Laurentius Marais & Katherine Schipper, *Event Study Methods: Detecting and Measuring the Security Price Effects of Disclosures and Interventions (New)*, *in* LITIGATION SERVICES HANDBOOK: THE ROLE OF THE FINANCIAL EXPERT 17A.1, 17A.9 (Roman L. Weil et al. eds., 3d ed. Supp. 2005).

124. *See* Mark L. Mitchell & Jeffry M. Netter, *The Role of Financial Economics in Securities Fraud Cases: Applications at the Securities and Exchange Commission*, 49 BUS. LAW. 545, 557-58 (1994).

125. *See id.* at 558.

126. *See id.* at 558-59.

compromise the ability of the event study to identify abnormal performance.[127]

After defining the event window, one must isolate the portion of the security return attributable to the news. The event study is primarily a method of determining whether estimated event effects fall outside the range that would be expected given the normal variation of stock returns, thereby allowing the remaining variation to be attributed to firm-specific factors. The first practical decision is whether to calculate the return series in gross[128] or logarithmic (log) form.[129] Although financial economists prefer the statistical properties of log series, this decision is likely to have little practical effect.[130]

The more significant determination is in modeling normal performance, or the "expected return." Model variants are largely divided into two categories: "statistical" and "economic."[131] Statistical models rely solely on the empirical behavior of asset returns, while economic models rely additionally on theories of individual investment behavior.[132] Because economic models impose additional statistical assumptions without offering significant practical advantage, economists prefer statistical models.[133] While statistical models do not rely on the validity of an underlying economic argument, they still assume that asset returns are jointly multivariate-normal and independent and identically distributed across time.[134]

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127. *See* David I. Tabak & Frederick C. Dunbar, *Materiality and Magnitude: Event Studies in the Courtroom* 8 (Nat'l Econ. Research Assocs., Working Paper No. 34, 1999).

128. These are arithmetically derived as the change in the stock price during the period, plus any dividends paid, divided by the previous closing price. The gross return can thus be expressed as $R_t = \frac{(P_t - P_{t-1}) + D_t}{P_{t-1}}$.

129. Researchers in financial economics generally prefer logarithmic return series, which are continuously compounded and expressed as the natural logarithm of one plus the gross return, or $LR_t = ln\left(\frac{P_t + D_t}{P_{t-1}}\right)$. The log transformation causes the return distribution to be closer to normal, which is the basis for the inference tests used to determine statistical significance. The assumption that continuously compounded single-day returns are independent and identically distributed has been called "the workhorse of the financial asset pricing literature." JOHN Y. CAMPBELL ET AL., THE ECONOMETRICS OF FINANCIAL MARKETS 15-16 (1997). Additionally, logarithmic returns have been found to produce better test specifications than tests based on arithmetic returns in event studies. *See* Charles J. Corrado & Cameron Truong, *Conducting Event Studies with Asia-Pacific Security Market Data*, 16 PAC.-BASIN FIN. J. 493, 509 (2008).

130. *See* Mitchell & Netter, *supra* note 124, at 560 n.96.

131. MacKinlay, *supra* note 118, at 17.

132. *Id.*

133. *See* CAMPBELL ET AL., *supra* note 129, at 156-57.

134. MacKinlay, *supra* note 118, at 17. This assumption, generally assumed to be of only minor significance, has been called into question and is the overriding concern regarding methodological choice in the finance literature. *See infra* Part III.

Part III below details the academic literature on methodological choice. For the purpose of describing the use of event studies in expert testimony, it is an adequate generalization that a "market model" event study that estimates predicted returns through the use of an ordinary least squares (OLS) regression is the standard adopted by most courts.[135] Using OLS, the analyst computes the historical relationship between the return on the asset and the return on the market by regressing the former on a representative market index and/or an index constructed to represent the return on companies within the same industry group.[136] The period over which this regression analysis is computed, the "estimation window" or "control period," is typically placed before the beginning of the "class period"[137] so that the distortionary effect of the allegedly misrepresented information will not influence the estimated historical relationship.[138] In this regard, conducting an event study for securities litigation departs from its application in the academic literature. In other environments it may be necessary to use postevent data to estimate the market model if there is a suspected time-varying change in the correlation between the stock and market returns.[139] However, a class action suit alleging fraudulent misrepresentations presupposes a discernable change in the pattern of stock returns, and using postdisclosure data would risk having the event impact the generated expected returns.

As noted above, the analyst must choose a market index to use in estimating the regression equation between the stock and the market returns. Event studies often use a market model with a single market index, such as the S&P 500.[140] These studies can also be augmented to include the return on a peer group, which frequently consists of firms in the same Standard Industrial

135. *See, e.g.*, Tabak & Dunbar, *supra* note 127, at 8 n.19 ("While some crude event studies are performed without adjusting for market effects, the literature nearly uniformly argues that a market adjustment is desirable. Moreover, there is relevant case law, such as *In Re Executive Telecard Ltd. Securities Litigation*, which states that in measuring stock price declines, one must eliminate 'that portion of the price decline that is the result of forces unrelated to the wrong.'" (quoting *In re* Exec. Telecard Ltd. Sec. Litig., 979 F. Supp. 1021, 1025 (S.D.N.Y. 1997))); *see also* Macey et al., *supra* note 68, at 1034-35 (claiming that the language of section 11 of the Securities Act implies a need for market adjustment); Mitchell & Netter, *supra* note 124, at 567 (describing the basic method for adjustment as the market model regression).

136. *See* Tabak & Dunbar, *supra* note 127, at 8-10.

137. The class period is the time between the first alleged misrepresentation and when the fraud is disclosed to the market, and it is the date range analyzed through expert testimony. Only purchasers of securities during the class period are eligible for recovery. *See* Eric Helland, *Reputational Penalties and the Merits of Class-Action Securities Litigation*, 49 J.L. & ECON. 365, 370 (2006).

138. *See* Tabak & Dunbar, *supra* note 127, at 9 & n.21.

139. *See* MacKinlay, *supra* note 118, at 20.

140. *See* Marais & Schipper, *supra* note 123, at 17A.11.

Classification (SIC) code.[141] Once the analyst has chosen the relevant dependent variable(s), an OLS regression is conducted of the daily security returns on the daily market returns over the estimation period, assuming the return on the stock is a function of the return on the market and an error component representing firm-specific effects. A representative single-factor market model is of the form:

$$security_t = \alpha + \beta market_t + \varepsilon_t$$

The estimated equation calculates a constant market-model intercept for the security, α (alpha), and a coefficient measure of the sensitivity of the firm's stock to the broader market, β (market beta). In practical terms, alpha represents the expected return of the security when the market return is zero, while the market beta represents the tendency of the security to react to a given change in the market. The daily predicted return is calculated as the sum of the market-model intercept term and the product of the market beta and contemporaneous return of the market index. For example, if a firm has an alpha of 0 and a market beta of 1.5, when the market index return is -1% the expected one-day return will be -1.5% (0% + 1.5 * -1% = -1.5%). The unexpected variation in the stock return—in the economic literature, the "abnormal return"—is simply the difference between the observed daily return of the stock and the calculated predicted return. This is mathematically identical to the daily residual, ε_t, computed through the regression equation.

The final stage of an event study is to analyze the statistical significance of the daily abnormal return. Because security prices fluctuate naturally, it is necessary to calculate the level of confidence that the event-induced abnormal return is not zero. This is accomplished by comparing the ratio of the estimated daily abnormal return, ε_t, to the standard deviation (a measure of the dispersion of a variable around its mean) of the residuals from the regression equation.[142] The resulting ratio is commonly referred to as a "*t*-statistic"[143] and

141. *Id.* at 17A.11-12. As the authors note, the appropriateness of including additional factors often depends on context and is largely an empirical question. *Id.* at 17A.12.

142. In practice, the root mean squared error, calculated as the square root of the sum of the squared residuals, is used as the divisor in the ratio. The estimated residual variance from the regression model and the standard deviation of the net-of-market returns over the estimation period are "virtually identical," with the root mean squared error being slightly more precise in accounting for firm-specific variation to the market. Mitchell & Netter, *supra* note 124, at 569 n.113; *see also* Pamela P. Peterson, *Event Studies: A Review of Issues and Methodology*, Q.J. BUS. & ECON., Summer 1989, at 43 (1989) (noting that the standard error of the estimated regression is used in standardizing abnormal returns when simple regression analysis is used).

143. The ratio of an estimate to its standard error is called the *t*-statistic, and because, in this instance, the statistic references the residual value of the regression, it is also known as the "studentized residual." *See* Gelbach et al., *supra* note 120, at 502.

can be compared to the probability density of the student *t* distribution[144]: a normally distributed variable will have 95% of its observations fall within approximately two standard deviations of its mean. Thus, by assuming that the returns adhere to normality, an event abnormal return will be found to have *not* occurred by chance when the absolute value of the *t*-statistic is greater than or equal to roughly 1.96.[145]

It should be noted that the ease of this comparison is contingent on the tested variable being distributed normally; if the returns come from a different distribution, inferences based on the probability density function will be inaccurate. Historically, it was assumed that the normal distribution was an accurate enough description of daily stock returns.[146] Even those studies acknowledging the non-normality of daily returns found it to be of little impact when interpreting the results of an event study.[147] However, recent literature has called this assumption into question, as demonstrated in Part III below.

B. Using an Event Study to Analyze Rule 10b-5 Requirements

Armed with the event study results, an expert witness is able to address reliance, materiality, loss causation, and damages. With regard to reliance, defendants often dispute whether the market for the company's security is semi-strong form efficient, a necessary predicate for *Basic*'s presumption of reliance.[148] For smaller, off-exchange securities, defense experts may be able to demonstrate low trading volume, a comparatively large bid-ask spread,[149] or

144. *See* Moultrie v. Martin, 690 F.2d 1078, 1084 n.10 (4th Cir. 1982) ("The student's t distribution, like the binomial distribution . . . is represented by a bell shaped curve. When the sample size is small, the student's t curve is flatter in the middle and plumper in the tails.").

145. This critical value is based on a two-tailed test, which compares the residual to the probability distribution in the two furthest ends of the bell curve. In theory, if you know the direction of the expected return, the proper comparison should be to only one end of the distribution (also known as a one-tailed test). For the sake of accuracy, I will use a two-tailed test when testing Type I errors—which by construction can be both positive and negative—whereas Type II power analyses will only test against the tail representing the sign of the imputed value.

146. *See, e.g.*, Mitchell & Netter, *supra* note 124, at 563.

147. *See, e.g.*, Macey et al., *supra* note 68, at 1039 n.67.

148. As mentioned in Part I.C.3 above, plaintiffs must establish that the market for the security in question is semi-strong form efficient to obtain the presumption of reliance established in *Basic*.

149. The bid-ask spread represents the difference between the price at which investors will buy a stock and the price at which holders of the security are willing to sell. Some courts have found a comparatively large bid-ask spread to be indicative of an inefficient market because "the stock is too expensive to trade." *See, e.g.*, Krogman v. Sterritt, 202 F.R.D. 467, 478 (N.D. Tex. 2001).

other objective bright-line standards in disputing efficiency. The more contentious battle, particularly for blue-chip stocks, lies in testing the fifth *Cammer* factor: whether a demonstrable relationship exists between the release of unexpected material information and a change in the price of the security. If it can be shown through an event study that the stock did not react in a statistically significant manner to value-relevant information, the court may find that the efficiency requirement is not satisfied and deny class certification.

The modern interpretation of materiality constituting information that affects investment decisions lends itself to empirical testing. As Frederick Dunbar and Dana Heller note:

> [O]ne can ask the economic question of how a change in investors' decisions to trade at a given price could be observed. The straightforward answer is that if the information would cause more investors to want to buy at a particular price, the previous supply-and-demand equilibrium would be upset and the price would have to rise until the demand for the stock once again equaled its supply. This, of course, says that materially positive news causes a stock's price to rise.[150]

From an economic perspective, it can only be confirmed that the price of the security reacted to news if the abnormal return is statistically significant; absent this determination, a price change could instead be merely an artifact of the normal daily fluctuation. The approach to materiality accepted by courts is therefore framed objectively and identified by an event study.[151]

Loss causation follows a similar pattern. Post-*Dura*, plaintiffs are required to demonstrate the causal link between the alleged harm and the purportedly fraudulent statements or actions by the company. Event studies are the cleanest mechanism available to establish this connection, and they can be used to demonstrate both that an economic loss occurred and that the loss can be proximately connected to the underlying misrepresentations.[152]

Finally, an event study is an integral component in computing damages. In order to determine class damages under the out-of-pocket measure stipulated in *Affiliated Ute*, the expert must establish the daily price at which the security would have traded had there been no fraudulent representations, also called a "value line."[153] For individual trades, damages can be calculated as the difference between the price paid and the value line, multiplied by the number

150. Dunbar & Heller, *supra* note 14, at 468.

151. *See, e.g.*, Gen. Elec. Co. v. Jackson, 595 F. Supp. 2d 8, 23-24 (D.D.C. 2009) (declaring that a regression-based event study was probative of the effect of environmental noncompliance letters on stock prices).

152. Kaufman & Wunderlich, *supra* note 1, at 198.

153. *See* Bradford Cornell & R. Gregory Morgan, *Using Finance Theory to Measure Damages in Fraud on the Market Cases*, 37 UCLA L. REV. 883, 885 (1990) (quoting Green v. Occidental Petrol. Corp., 541 F.2d 1335, 1344 (9th Cir. 1976) (Sneed, J., concurring in part and concurring in the result in part)).

of shares purchased.[154] In the aggregate, class damages can be approximated by the daily disparity between the share price and the value line, multiplied by the volume of shares traded.[155] Because calculating the value line with reference to fundamental company value, earnings data, or analyst expectations involves inherently subjective components, the task of calculating the value line has been delegated to the event study.[156]

As recognized in Part I.3.C above, the proper approach to the damages portion of a securities fraud suit is unsettled, which has led to substantial differences in methodology. Although an exhaustive discussion of the competing methods and comparative benefits of each approach is beyond the scope of this Note,[157] suffice it to say that if the opposing experts disagree on the event study model used for purposes of reliance or materiality, their measures of damages will likely differ by an order of magnitude. This divergence will have significant effects on the parties' ability to reach a settlement agreement that is in both sides' interest. Given the critical reliance on event studies at each stage of the securities fraud process, there exists a surprising paucity of studies empirically analyzing the performance of different event study models.

III. Literature Review on Event Study Models

The event study is "one of the most frequently used analytical tools" in corporate finance research.[158] Before the advent of the modern event study in 1969, there was little empirical evidence of the central issues of financial economics, whereas "[n]ow we are overwhelmed with results, mostly from event studies."[159] The ability to isolate the impact of a broad range of corporate events occurring in capital markets led to a dramatic increase in published articles using the event study technique; Kothari and Warner report that

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154. Alexander, *supra* note 104, at 1429.

155. *Id.* at 1429-30.

156. *See* Cornell & Morgan, *supra* note 153, at 888.

157. For excellent reviews of the issues associated with measuring damages in securities class action lawsuits, see Robert A. Alessi, *The Emerging Judicial Hostility to the Typical Damages Model Employed by Plaintiffs in Securities Class Action Lawsuits*, 56 BUS. LAW. 483 (2001); Janet Cooper Alexander, *Rethinking Damages in Securities Class Actions*, 48 STAN. L. REV. 1487 (1996); Michael Barclay & Frank C. Torchio, *A Comparison of Trading Models Used for Calculating Aggregate Damages in Securities Litigation*, LAW & CONTEMP. PROBS., Spring/Summer 2001, at 105; and Edward I. George & William E. Wecker, *Estimating Damages in a Class Action Litigation*, 3 J. BUS. & ECON. STAT. 132 (1985).

158. Peterson, *supra* note 142, at 36.

159. Eugene F. Fama, *Efficient Capital Markets: II*, 46 J. FIN. 1575, 1600 (1991).

between 1974 and 2000, 565 papers containing event studies were published in five finance journals alone.[160]

The event study method as commonly used was established in an influential 1969 paper by Eugene Fama, Lawrence Fisher, Michael Jensen, and Richard Roll.[161] In examining the effect of stock split announcements on the value of common equity, the authors established the textbook table layout that is still the basis of the standard event study.[162] Although the structural format of an event study has remained stable, significant intellectual resources have been devoted to researching more sophisticated statistical modeling techniques and more accurate means of adjusting the measure of statistical significance to ensure the validity of inferences drawn from event studies.[163]

Beginning in the 1980s, a parallel literature developed analyzing the comparative ability of the various preexisting statistical models to detect abnormal performance. A pair of seminal companion articles written by Stephen Brown and Jerold Warner analyzed the specification properties of these models and their ability to detect abnormal performance using monthly[164] and daily[165] data. Brown and Warner's 1985 paper, which "has since come to eponymously define the genre,"[166] found that event studies presented few practical difficulties when using daily data.[167] Although daily returns clearly departed from normality, methodologies based on OLS market models were "well-specified under a variety of conditions."[168] The academic community was generally convinced that event studies represented an empirically valid method of testing financial hypotheses, even given the strict assumptions generally required in parametric hypothesis testing.

Dozens of papers have been published testing the properties of competing event study methods.[169] These studies analyze two primary characteristics: how frequently the statistical test rejects the null hypothesis of no abnormal price performance, and how frequently the null hypothesis is rejected in the presence of a known abnormal return.[170] The first inquiry, often known as the

160. Kothari & Warner, *supra* note 2, at 6.
161. Fama et al., *supra* note 117.
162. *See* Kothari & Warner, *supra* note 2, at 8.
163. *See id.*
164. Brown & Warner, *supra* note 3.
165. Brown & Warner, *supra* note 4.
166. Charles J. Corrado, *Event Studies: A Methodology Review*, 51 ACCT. & FIN. 207, 213 (2011).
167. Brown & Warner, *supra* note 4, at 25.
168. *Id.*
169. Kothari & Warner, *supra* note 2, at 5.
170. *See* John J. Binder, *The Event Study Methodology Since 1969*, 11 REV. QUANTITATIVE FIN. & ACCT. 111, 120 (1998).

"analysis of specification," tests whether the Type I error rate (i.e., when the null hypothesis of no abnormal performance is falsely rejected) approaches the error rate of the assumed size of the test.[171] The second inquiry, called the "analysis of power," tests the ability of a model to detect abnormal price performance when it exists; the failure to do so is known as a Type II error.[172] When comparing tests that are well specified, the test with higher power is preferred. Using pseudo-simulations, "artificial" abnormal performance is imputed into actual stock returns, and the ability of different models to detect statistically significant abnormal returns is analyzed.[173]

The initial comparative performance studies evaluated the mean-adjusted return model, the market-adjusted return model, and the OLS market model. The mean-adjusted model calculates abnormal returns by simply subtracting the average return of the stock during the estimation period and comparing each out-of-sample daily abnormal return to the standard deviation of the average.[174] This method does not explicitly control for the idiosyncratic risk of the stock or the contemporaneous return on the market. The market-adjusted return model subtracts the return on the market from the daily return and compares the difference in the event period to its mean and standard deviation in the control period.[175] As detailed in Part II above, the market model approach calculates abnormal performance by using pre-event period returns and an OLS regression. This approach controls for both the risk of the stock (as measured by its market beta) and the simultaneous returns on the market.[176]

The initial Brown and Warner studies were notable for finding that modeling choice did not have a material impact on the performance of event studies.[177] Although the authors found that daily data presented few difficulties for properly conducting an event study, they did acknowledge that an increase in security variance could lead to too many rejections of the null hypothesis that the average excess return is zero.[178]

Later empirical studies questioned the findings of these initial counterintuitive results. Ramesh Chandra, Shane Moriarity, and G. Lee Willinger demonstrated that the comparability in performance of the mean-

171. *See* Kothari & Warner, *supra* note 2, at 12. The assumed size of the test corresponds to the confidence level used in testing statistical significance: a test based on a 95% confidence level should result in tests results finding statistical significance 5% of the time.

172. *See id.*

173. *See, e.g.*, Brown & Warner, *supra* note 4, at 8-16.

174. *See id.* at 6-7.

175. *See id.* at 7.

176. *See id.*

177. Brown & Warner, *supra* note 3, at 249; Brown & Warner, *supra* note 4, at 12.

178. Brown & Warner, *supra* note 4, at 23.

adjusted and market-adjusted return models was largely a statistical artifact of model implementation.[179] More generally, many academics challenged the notion that violations of normality in the underlying returns of the security were irrelevant to the performance of the model. Subsequent research verified the Brown and Warner conclusion that abnormal returns are not normally distributed, but it instead found this violation to cause significant problems of inference, leading to both under- and overrejection of the null.[180] For "outlier-prone data," prevalent in financial markets, the true Type I error rate will be larger than that associated with particular asymptotic values, with greater discrepancies found in stock returns with higher levels of kurtosis.[181]

Recognizing the limitations of standard inference tests in the presence of normality violations, scholars searched for alternative statistical models that would be robust to the empirical distribution of abnormal returns. Some have proposed using nonparametric tests of abnormal performance, which make no assumption about the probability distribution of the variables. The most successful of the nonparametric tests have been the rank and sign tests. More applicable to the context of single-firm, single-event studies, the nonparametric rank test transforms the distribution of the abnormal returns into a uniform distribution across rank values irrespective of the original distribution.[182] An alternative method is to normalize the conventional *t*-statistics from the market model regression with bootstrap resampling.[183] Evidence on the performance of bootstrap methods has been mixed and varies with the bootstrap resampling's application; as a result, it has not enjoyed popular support in the event study literature.[184] The overall conclusion from these articles is that alternative event study methods, whether parametric or

179. *See* Ramesh Chandra et al., *A Reexamination of the Power of Alternative Return-Generating Models and the Effect of Accounting for Cross-Sectional Dependencies in Event Studies*, 28 J. ACCT. RES. 398, 400 (1990).

180. *See, e.g.*, George S. Ford & Audrey D. Kline, Event Studies for Merger Analysis: An Evaluation of the Effects of Non-Normality on Hypothesis Testing (Aug. 2006) (unpublished manuscript), http://ssrn.com/abstract=925953.

181. Scott E. Hein & Peter Westfall, *Improving Tests of Abnormal Returns by Bootstrapping the Multivariate Regression Model with Event Parameters*, 2 J. FIN. ECONOMETRICS 451, 456 (2004). Kurtosis is formally defined as "the standardized fourth population moment about the mean" and is used to describe "the type and magnitude of departures from normality." Lawrence T. DeCarlo, *On the Meaning and Use of Kurtosis*, 2 PSYCHOL. METHODS 292, 292, 302 (1997).

182. Charles J. Corrado, *A Nonparametric Test for Abnormal Security-Price Performance in Event Studies*, 23 J. FIN. ECON. 385, 388 (1989).

183. *See, e.g.*, Lisa A. Kramer, *Alternative Methods for Robust Analysis in Event Study Applications*, *in* 8 ADVANCES IN INVESTMENT ANALYSIS AND PORTFOLIO MANAGEMENT 109 (Cheng-Few Lee ed., 2001).

184. Corrado, *supra* note 166, at 216.

variations based on empirical resampling of the abnormal return distribution, should be implemented when the data are distributed non-normally.

Scholars have recently scrutinized the application of event studies in particular relation to their use in litigation. Corrado notes that single-security event studies are rarely reviewed in academic literature but are routinely used in legal proceedings.[185] He advises legal practitioners to use a simple modification of the standard event study approach, which "merely involves counting the number of returns from the control period that are larger or smaller than the event date return."[186] In reviewing event studies as applied to Rule 10b-5 securities fraud cases, Gelbach et al. propose a similar modified event study procedure called the "SQ test."[187] Like the test endorsed by Corrado, the SQ test involves ranking the abnormal returns from the market model regression and testing whether the event-date abnormal return is larger (or smaller) than the abnormal return quantile corresponding to a given confidence level.[188] Refuting the doctrinal reliance on the central limit theorem,[189] the authors prove that the large-sample behavior of the *t*-statistic will be normal only if the abnormal return distribution is itself normal.[190] As a result, standard parametric approaches may yield biased results depending on the size of the event effect and the deviation of the empirical return values from the normal distribution.[191] Using a dataset containing the returns for all securities in the Center for Research in Security Performance's (CRSP) database from 2000 to 2007, the authors find evidence of substantial bias against finding statistically significant abnormal returns.[192]

There has also been increased scholarly interest in the effect of changes in volatility on the inference properties of event studies. Brown and Warner's initial comparative review using daily data noted that an increase in variance would lead to too many rejections of the null hypothesis of no abnormal performance.[193] Aktas, De Bodt, and Cousin note that idiosyncratic volatility is not constant through time and that individual stocks have become more

185. *Id.* at 209.

186. *Id.* at 211.

187. Gelbach et al., *supra* note 120, at 497.

188. *See id.*

189. The central limit theorem is a common, convenient justification for assuming normality in random data. *Id.* at 510.

190. *Id.* at 510-11.

191. *Id.* at 525.

192. *See id.* at 513.

193. Brown & Warner, *supra* note 4, at 23.

volatile over recent decades.[194] Although they do not find an effect on specification tests, the power of event studies to detect abnormal performance varies with idiosyncratic volatility.[195] The authors ultimately conclude that "there is no practical solution to this problem" outside of "increas[ing] the sample size to compensate for the increase in . . . volatility."[196]

IV. Data and Methodology

A. The Financial Crisis and Return Series Data

This Note attempts to answer the questions whether the standard OLS market model or the alternative model proposed by Gelbach perform adequately when used to analyze return series during the financial crisis of 2007-2008, and if not, whether there are readily available alternatives that can be substituted by courts. As previously discussed in Part III, large increases in variance can result in misspecification of the event study model. Given the speed and depth of the shift in market volatility associated with the recent crisis, a reasonable a priori hypothesis is that unadjusted models will overreject the null hypothesis of no abnormal return. If not sufficiently appreciated by courts, this overrejection will lead to a finding of significant event effects where none exist.

An exhaustive review of the events precipitating the collapse of the financial markets is unnecessary for this analysis. However, for the purpose of explaining the date range used to compare results across models, I briefly explain some of the larger events that have been viewed as guideposts to understanding the financial crisis. The decision by BNP Paribas, a French investment bank, to suspend redemptions in three investment funds is considered by many as the "ringing of the bell" marking the beginning of the 2007 liquidity crisis.[197] On August 9, 2007, BNP withheld redemptions following massive reductions in fund value, while also stating that "the complete evaporation of liquidity in certain market segments of the US securitization market has made it impossible to value certain assets fairly regardless of their quality or credit rating."[198] The resulting panic in the

194. Nihat Aktas et al., *Idiosyncratic Volatility Change and Event Study Tests*, 30 FINANCE, no. 2, 2009, at 31, 33.

195. *Id.* at 35.

196. *Id.*

197. NAT'L COMM'N ON THE CAUSES OF THE FIN. & ECON. CRISIS IN THE U.S., THE FINANCIAL CRISIS INQUIRY REPORT 250-51 (2011) [hereinafter FCIC REPORT].

198. *Id.* (quoting Press Release, BNP Paribas, BNP Paribas Investment Partners Temporaly [sic] Suspends the Calculation of the Net Asset Value of the Following Funds: Parvest Dynamic Abs, BNP Paribas Abs Euribor and BNP Paribas Abs Eonia (Aug. 9, 2007),
footnote continued on next page

commercial paper and repurchase agreement markets led to swift government action, with the Federal Reserve committing to provide liquidity in order to facilitate the functioning of financial markets.[199]

The failure of Lehman Brothers on September 15, 2008 led to a run on money market funds and a spike in the commercial paper market.[200] Afterwards, even large industrial corporations, removed from the financial instruments at the heart of the crisis, found it difficult to sell their commercial paper.[201] Markets remained in turmoil following Lehman's collapse, culminating in the Federal Reserve bailout of AIG, the Reserve Primary Fund "breaking the buck,"[202] and congressional approval of the $700 billion Troubled Asset Relief Program.[203] The precise period when the crisis in the financial markets officially abated is less clear. For the purposes of this Note, I chose February 23, 2009, when the Treasury Department, Federal Deposit Insurance Corporation, Office of the Comptroller of the Currency, Office of Thrift Supervision, and the Federal Reserve Board issued a joint statement that "the U.S. government stands firmly behind the banking system, and that the government will ensure that banks have the capital and liquidity they need to provide the credit necessary to restore economic growth."[204]

The turmoil in the equity market can be viewed schematically by analyzing the value of the VIX Index, a barometer of equity market volatility produced by the Chicago Board Options Exchange,[205] over the crisis period. The VIX Index, often referred to as the market's "fear gauge," is designed to measure investor consensus of the thirty-day expected stock market volatility.[206] For empirical analysis, given that a stock price represents a claim on prospective value, the VIX Index is preferred as a volatility proxy to alternatives that only capture historical patterns. The Index value is calculated through the implied volatility of near- and next-term put and call options with

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http://www.bnpparibas.com/en/news/press-release/bnp-paribas-investment-partners-temporaly-suspends-calculation-net-asset-value-fo).

199. *Id.* at 252.

200. *See id.* at 339.

201. *See id.*

202. "Breaking the buck" is a euphemism used for the net asset value of a money market fund falls below the one-dollar mark.

203. *The Financial Crisis: Full Timeline*, FED. RESERVE BANK ST. LOUIS, https://www.stlouisfed.org/financial-crisis/full-timeline (last visited May 5, 2016).

204. *Id.*

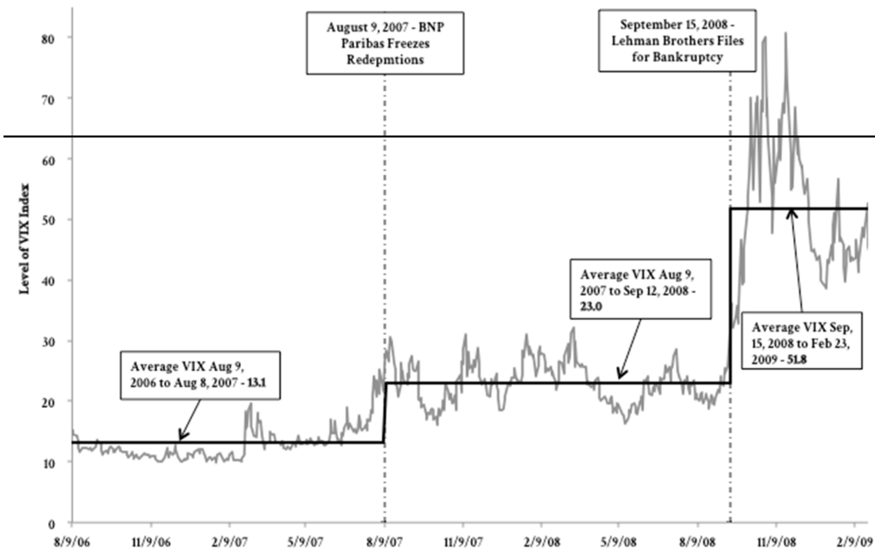
205. *VIX® Index & Volatility*, CHI. BD. OPTIONS EXCH., http://www.cboe.com/micro/vix-and-volatility.aspx (last visited May 5, 2016).

206. *Id.*

expiration dates falling between twenty-three days and thirty-seven days.[207] Figure 1 shows movements in the VIX Index in relation to the dates specified above.

Figure 1

VIX Level over the Financial Crisis Period and One Year Prior
August 9, 2006 to February 23, 2009



The trend is clear: beginning around the time of the BNP decision to freeze redemptions, the VIX Index rose by roughly seventy-five percent, from an annualized level of 13.1 to 23.0 over the period before Lehman's collapse. Following Lehman's failed rescue attempt and ultimate bankruptcy, the VIX Index increased drastically, more than doubling in value over the period from September 15, 2008 to February 23, 2009. The market visibly expected the variance in future returns on the S&P 500 to be an order of magnitude higher than that expected less than a year earlier. With such a dramatic increase in expected volatility, presumably the return series of common stocks constituting the Index would be structurally different from prior period returns. Considering that event studies rely on normally distributed security returns, this precipitous change in variance structure is likely to result in violations of the normality assumption of a properly specified event study model.

207. Chi. Bd. Options Exch., White Paper: The CBOE Volatility Index—VIX 5 (2014), http://www.cboe.com/micro/vix/vixwhite.pdf.

The specification and analysis of power tests in the following Part include data for the twenty-nine securities in the Dow Industrial Index at the time of the financial crisis, less General Motors, which received a government bailout during this period.[208] The return series were downloaded from Bloomberg L.P. using a logarithmic transformation and are adjusted for dividends and stock splits. The VIX Index data were also downloaded from Bloomberg and have been recalibrated as the annualized traded value of the S&P 500 options' implied volatility divided by the square root of 250 (the approximate number of trading days in a year). Thus, the VIX parameter used in the event study analysis is the daily value of the implied volatility. The independent variable in the regression equation is the log return of the S&P 500 Total Return Index, which includes reinvestment of ordinary and special dividends.[209] Summary statistics of the twenty-nine securities used in the analysis are presented in Table 1.

208. FCIC REPORT, *supra* note 197, at 375.

209. S&P DOW JONES INDICES, S&P U.S. INDICES: METHODOLOGY 26 (2016), http://us.spindices.com/indices/equity/sp-500 (to locate, select "Methodology" and follow hyperlink).

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Table 1
Summary Statistics of Returns on Dow 30 Companies, 2009

	Name	Ticker	Mean	Standard Deviation	Kurtosis	Skew	Chi-squared	p-value	Normally Distributed?
1	Alcoa	aa	-0.46%	4.58%	7.08	-0.02	34.14	0.00	No
2	AIG	aig	-1.24%	9.18%	35.42	-3.49		0.00	No
3	American Express	axp	-0.42%	4.19%	5.63	-0.27	26.95	0.00	No
4	Boeing	ba	-0.27%	2.70%	6.56	0.38	37.39	0.00	No
5	Citigroup	c	-0.79%	6.93%	11.17	0.23	57.42	0.00	No
6	Caterpillar	cat	-0.29%	2.91%	6.19	0.04	27.96	0.00	No
7	DuPont	dd	-0.23%	2.75%	6.51	-0.36	36.32	0.00	No
8	Walt Disney	dis	-0.17%	2.77%	7.67	0.33	42.93	0.00	No
9	GE	ge	-0.37%	3.27%	6.69	-0.13	32.35	0.00	No
10	Home Depot	hd	-0.17%	2.99%	4.49	0.51	25.16	0.00	No
11	Honeywell International	hon	-0.18%	2.63%	5.05	-0.09	18.98	0.00	No
12	HP	hpq	-0.13%	2.68%	6.65	0.58	45.70	0.00	No
13	IBM	ibm	-0.07%	2.17%	5.53	0.26	25.95	0.00	No
14	Intel	intc	-0.17%	3.02%	4.91	-0.18	19.00	0.00	No
15	Johnson & Johnson	jnj	-0.03%	1.57%	15.08	0.93		0.00	No
16	JPMorgan	jpm	-0.21%	4.97%	7.10	0.05	34.40	0.00	No
17	Coca-Cola	ko	-0.06%	1.96%	11.10	0.87		0.00	No
18	McDonald's	mcd	0.03%	1.93%	5.70	0.11	24.71	0.00	No
19	3M Company	mmm	-0.16%	2.10%	6.36	-0.07	29.41	0.00	No
20	Altria	mo	-0.07%	2.05%	15.53	0.05	69.08	0.00	No
21	Merck	mrk	-0.15%	2.69%	8.91	-0.74	66.74	0.00	No
22	Microsoft	msft	-0.13%	2.82%	8.23	0.35	46.82	0.00	No
23	Pfizer	pfe	-0.13%	2.16%	7.32	-0.22	38.12	0.00	No
24	Procter and Gamble	pg	-0.06%	1.71%	8.88	-0.15	45.60	0.00	No
25	ATT	t	-0.13%	2.54%	8.08	0.73	61.80	0.00	No
26	United Technologies	utx	-0.13%	2.41%	7.44	0.55	49.61	0.00	No
27	Verizon	vz	-0.09%	2.41%	6.93	0.46	42.78	0.00	No
28	Wal-Mart	wmt	0.01%	1.97%	7.46	0.22	38.87	0.00	No
29	Exxon	xom	-0.05%	2.81%	10.61	0.22	54.84	0.00	No

Note: Summary statistics are based on log return series. The test for normally distributed returns is based on the stata command *sktest*. Empty values for the chi-squared test represent "absurdly high numbers" and should be interpreted as highly non-normal.

Table 1 reveals that the security returns for these twenty-nine companies are not normally distributed over the crisis period. Skewness and kurtosis are the third and fourth standardized moments around the mean, and they are "used to describe shape characteristics of a distribution."[210] The normal distribution has a skewness of zero and a kurtosis of three, and the deviations from normality can be described by comparing the values of these moments.[211] To assess whether the returns depart from the normal distribution, I performed the test described by D'Agostino, Belanger, and D'Agostino, Jr. in 1990[212] with the empirical correction developed by Patrick Royston in 1991.[213] The chi-squared results for each security are highly statistically significant, indicating the presence of non-normality. For three securities—AIG, Johnson & Johnson, and Coca-Cola—the return distribution is so non-normal that standard statistical software fails to calculate the statistic.

An alternative means of testing for non-normally distributed data recommended by statisticians is to generate a normal probability plot relating the empirical return series to the normal distribution.[214] Figure 2 generates two normal probability plots, one for a financial firm (AIG) and one for an industrial corporation (Caterpillar).

210. D.N. Joanes & C.A. Gill, *Comparing Measures of Sample Skewness and Kurtosis*, 47 STATISTICIAN 183, 183 (1998).

211. Ralph B. D'Agostino et al., Commentary, *A Suggestion for Using Powerful and Informative Tests of Normality*, 44 AM. STATISTICIAN 316, 317 (1990).

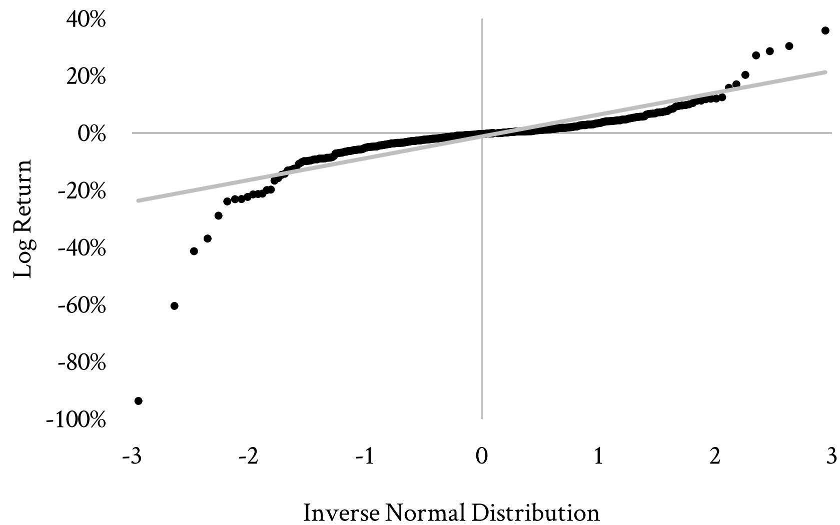
212. *Id.*

213. Patrick Royston, *Comment on sg3.4 and an Improved D'Agostino Test*, STATA TECHNICAL BULL., Sept. 1991, at 23-24.

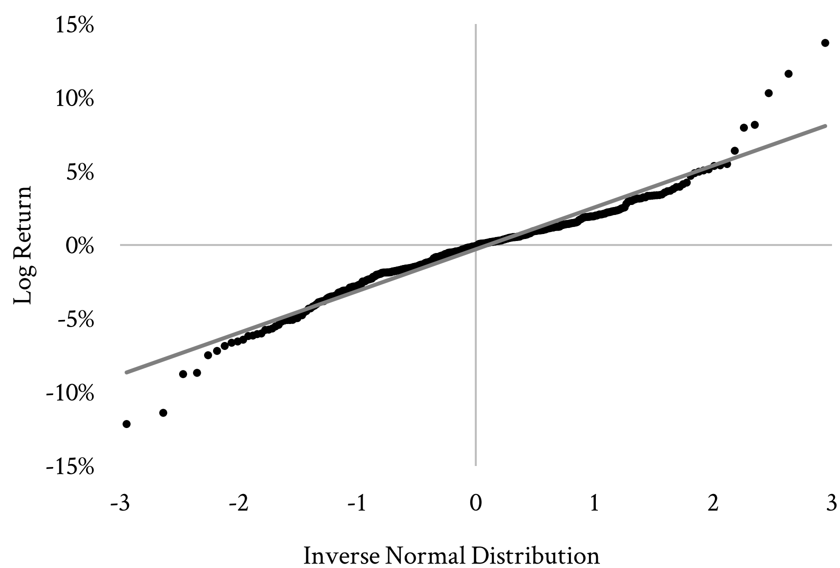
214. *See* D'Agostino et al., *supra* note 211, at 319.

Figure 2

AIG
August 9, 2007 to February 23, 2009



Caterpillar
August 9, 2007 to February 23, 2009



Both charts plot the ordered log security returns over the crisis period against the inverse of the standard normal cumulative distribution. If the return series were normally distributed, the data points would lie along a straight line. Instead, clear evidence exists of the canonical "fat tail" distribution common to financial markets;[215] there are too many very large and very small returns. Given this pattern, there is reason to believe that standard parametric inference tests will cause overrejection of the null hypothesis.

B. Market Models and Event Windows

In conducting the specification and power tests in the spirit of a Brown and Warner study, this Note examines the results of four event study models over the financial crisis: two models previously established in the academic canon—the standard OLS market model and the SQ test proposed by Gelbach—as well as two novel event study models that directly control for changes in market volatility—an OLS market model with a VIX standard error correction[216] and a feasible generalized least squares (FGLS) market model.[217] The VIX-adjusted and FGLS market models adjust for contemporaneous changes in volatility through slightly different econometric methods, and both have been proffered by expert witnesses in federal securities lawsuits. A detailed explanation of the precise model form of each competing methodology can be found in the Appendix to this Note.

Sensitivity to the choice of estimation window is analyzed by comparing results across models with event study estimation windows corresponding to the one-year period preceding the financial crisis (pre-period window),[218] the 250 days directly abutting each calculated abnormal return (rolling window),[219] and the crisis period itself (in-sample window). As noted above, the estimation window is the time period over which the relationship between the return on the security and the return on the market is estimated.

215. Adrian Pagan, *The Econometrics of Financial Markets*, 3 J. EMPIRICAL FIN. 15, 37 (1996).

216. Expert Report of Gregg A. Jarrell at 32-33, *In re* Countrywide Fin. Corp. Sec. Litig., 273 F.R.D. 586 (C.D. Cal. 2009) (No. CV-07-05295-MRP (MANx)), 2010 WL 6681871.

217. Expert Report of Mukesh Bajaj at 45, *In re* Fed. Home Loan Mortg. Corp. (Freddie Mac) Sec. Litig., 281 F.R.D. 174 (S.D.N.Y. 2012) (No. 1:09-MD-2072 (MGC)), 2011 WL 7473682.

218. For all but the SQ test this estimation window is August 9, 2006 to August 8, 2007. The SQ test compares residual returns to the empirically derived critical values and is best conducted using an estimation period with a number of returns that is a multiple of the critical value. *See* Gelbach et al., *supra* note 120, at 523. Using a two-tailed test and a 95% confidence level, we will be looking at the 2.5% and 97.5% critical values. With this consideration in mind, the estimation period is modified to start on August 24, 2006, resulting in a 240-day estimation window and critical level abnormal returns of the 6th and 234th largest returns.

219. Following a similar logic to that discussed in note 218 above, the rolling window consists of 240 trading days for the SQ-test event studies.

Accordingly, the pre-period window regressions estimate the relationship once with data from before the crisis and use the estimated parameters to predict expected returns during the crisis period. Rolling window event studies conduct a separate estimation for each predicted daily return, using only the most recent 250 daily returns. Finally, in-sample event studies use the daily returns from the crisis period itself to estimate predicted returns, with each abnormal return calculated as the residual from the regression procedure.

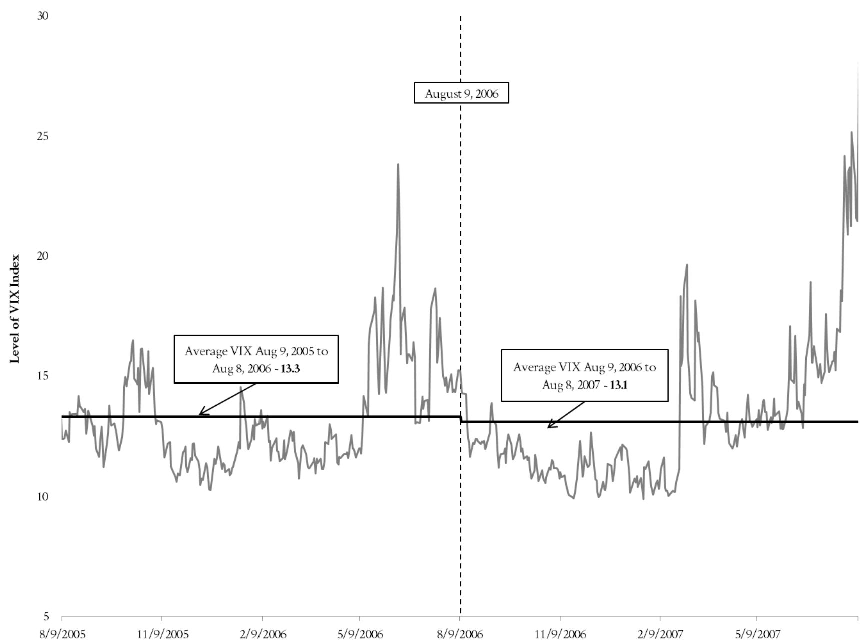
V. Results

Using the models developed in Part IV above, the specification and power tests were applied to the twenty-nine stocks in the sample. For the specification analysis, using the abnormal returns and *t*-statistics from the event study, the average rejection rate was computed over the financial crisis period for each security. A properly specified event study model will have a rejection frequency close to the confidence level determined by the test. Thus, for an event study calculating statistical significance with 95% certainty, approximately 5% of the abnormal returns over the period should be statistically significant. The power test examines the ability of each model to detect abnormal performance when it exists. Here, "artificial" abnormal performance is imputed into the empirical return series, and statistical significance is calculated as to the modified return.

A. Type I Error, Specification Test

For a first-pass analysis, it is helpful to test whether a model performs adequately even in the absence of changes in volatility. A proposed event study technique that modifies the standard to incorporate the effect of marketwide changes in variance should also be able to detect abnormal performance when security returns approach normality. Figure 3 charts the level of the VIX Index over the two years before BNP froze redemption in its investment funds. Although variation exists, there is no general time trend that would be expected to bias the results. Separated into one-year periods, the levels of the VIX Index are nearly equivalent, thus giving no reason to believe that pre-period estimation window results would be biased.

Figure 3
VIX Level over the Two Years Prior to the Start of the Financial Crisis
August 9, 2005 to August 8, 2007



Given this pattern in market volatility over the prior sampling period and the conclusions of Brown and Warner regarding the immateriality of model choice, we would expect to find similar performance across event study techniques. Table 2 demonstrates the specification properties of the four event study models, estimated over the three sampling windows for the one-year trading period preceding the financial crisis.

Table 2
Rejection Frequencies: August 9, 2006 to August 8, 2007
Using a 95% Confidence Interval and Two-Tailed Test

	Pre-Period Window				Rolling Window				In-Sample Window			
	OLS	SQ	VIX Adj.	FGLS	OLS	SQ	VIX Adj.	FGLS	OLS	SQ	VIX Adj.	FGLS
3M	2.0%	3.2%	1.6%	2.0%	2.0%	3.6%	1.6%	2.0%	3.6%	4.8%	4.0%	4.8%
AIG	3.2%	5.6%	4.0%	4.8%	3.6%	4.8%	4.0%	4.8%	4.0%	4.8%	4.8%	4.0%
Alcoa	6.8%	7.2%	6.8%	10.0%	6.4%	7.2%	6.4%	7.6%	6.4%	4.8%	5.2%	7.2%
Altria	2.4%	5.2%	3.6%	4.0%	3.6%	5.2%	3.2%	4.0%	3.6%	4.8%	4.0%	4.8%
American Express	5.2%	4.4%	5.2%	6.4%	6.4%	6.0%	6.4%	8.8%	4.8%	4.8%	4.8%	5.2%
ATT	8.4%	5.2%	9.6%	10.8%	6.0%	4.4%	8.4%	8.8%	5.6%	4.8%	6.4%	10.0%
Boeing	4.0%	4.0%	3.6%	3.6%	4.0%	4.4%	3.6%	4.0%	4.4%	4.8%	6.0%	8.8%
Caterpillar	5.2%	5.6%	4.8%	6.0%	4.4%	5.2%	4.0%	5.6%	3.6%	4.8%	2.8%	6.8%
Citigroup	8.4%	8.8%	7.2%	8.4%	6.8%	6.0%	5.6%	7.2%	6.0%	4.8%	4.8%	6.4%
Coca-Cola	5.2%	4.8%	4.8%	5.6%	5.2%	6.0%	4.4%	5.2%	4.8%	4.8%	2.8%	4.8%
Disney	1.6%	3.6%	3.6%	3.6%	3.6%	3.2%	2.8%	4.0%	5.6%	4.8%	6.0%	8.0%
DuPont	6.0%	5.6%	7.6%	7.6%	6.0%	4.8%	6.8%	9.2%	4.4%	4.8%	5.2%	7.2%
Exxon	6.0%	4.8%	8.4%	9.6%	5.6%	5.2%	8.8%	9.2%	4.8%	4.8%	8.4%	12.7%
GE	5.2%	4.4%	4.8%	6.0%	6.0%	5.2%	5.2%	7.2%	3.6%	4.8%	4.4%	6.8%
Hewlett Packard	0.8%	0.8%	1.6%	2.0%	2.8%	2.4%	2.8%	3.6%	5.2%	4.8%	6.4%	9.2%
Home Depot	5.2%	5.6%	6.0%	7.6%	5.6%	5.2%	5.2%	6.4%	4.8%	4.8%	6.0%	6.8%
Honeywell	3.2%	3.2%	4.0%	4.4%	5.6%	5.2%	4.8%	5.6%	6.4%	4.8%	5.6%	6.0%
IBM	7.2%	4.8%	6.8%	9.6%	8.4%	5.6%	6.8%	9.2%	4.8%	4.8%	4.4%	5.6%
Intel	2.8%	2.8%	3.6%	4.0%	4.8%	4.8%	4.0%	4.4%	5.2%	4.8%	4.4%	7.6%
Johnson & Johnson	3.6%	3.2%	2.8%	3.6%	5.2%	4.8%	5.2%	6.0%	4.8%	4.8%	6.4%	6.4%
JPMorgan	4.0%	4.8%	4.8%	4.8%	4.0%	4.4%	4.4%	4.8%	4.8%	4.8%	5.2%	6.0%
McDonald's	0.0%	0.8%	0.4%	0.4%	2.4%	1.2%	2.4%	3.6%	6.8%	4.8%	7.2%	10.0%
Merck	3.2%	4.0%	3.2%	3.6%	3.6%	4.8%	4.4%	5.2%	3.6%	4.8%	3.6%	5.2%
Microsoft	2.0%	6.0%	2.4%	3.6%	2.0%	4.4%	2.0%	3.2%	6.0%	4.8%	8.0%	10.0%
Pfizer	0.8%	1.6%	1.2%	2.0%	1.6%	2.0%	2.0%	3.2%	2.0%	4.8%	3.2%	6.0%
Procter & Gamble	2.4%	2.8%	2.0%	2.0%	4.0%	4.8%	2.0%	2.8%	5.2%	4.8%	4.0%	3.6%
United Technologies	2.4%	2.4%	3.2%	3.2%	4.4%	5.2%	3.2%	4.0%	5.2%	4.8%	5.2%	8.0%
Verizon	8.8%	8.0%	9.2%	10.4%	7.2%	8.0%	9.2%	10.0%	6.0%	4.8%	6.0%	7.2%
Wal-Mart	5.2%	4.4%	6.0%	7.2%	5.2%	4.0%	5.6%	6.8%	5.2%	4.8%	6.0%	9.2%
Mean	4.2%	4.4%	4.6%	5.4%	4.7%	4.7%	4.6%	5.7%	4.8%	4.8%	5.2%	7.0%
Standard Deviation	2.4%	1.9%	2.4%	2.9%	1.7%	1.4%	2.1%	2.3%	1.1%	0.0%	1.4%	2.1%

The results in Table 2 support the notion that model choice has little effect on the specification properties of an event study when market volatility is stable. Regardless of statistical method or sampling window, the rejection

frequencies are close to the expected value given a 95% confidence level test. Although the average rejection rates are comparable, using a rolling window estimation period does reduce the variance in the rejection frequencies across securities. Given that event studies in securities fraud cases are used for a single security, a smaller variance in rejection frequencies would be preferable, all else equal. This would suggest a convergence on the part of individual securities to the desired Type I error level attached to the test.

Table 3 reports the results of the same analysis performed over the financial crisis. Considering the known statistical violations of normality in the return series, rejection frequencies would be expected to diverge significantly from the 5% level stipulated by the test. If the model variants proposed by Jarrell and Bajaj[220] are capable of controlling for the increase in variance, the VIX-adjusted and FGLS event study models should result in rejection frequencies closer to the value determined by the confidence level of the test.

220. *See supra* notes 216-17 and accompanying text.

Table 3
Rejection Frequencies During the Financial Crisis
Using a 95% Confidence Interval and Two-Tailed Test

	Pre-Period Window				Rolling Window				In-Sample Window			
	OLS	SQ	VIX Adj.	FGLS	OLS	SQ	VIX Adj.	FGLS	OLS	SQ	VIX Adj.	FGLS
3M	14.7%	21.1%	0.8%	2.3%	8.2%	9.5%	2.6%	3.9%	5.4%	4.9%	4.6%	6.2%
AIG	64.2%	66.0%	38.7%	36.6%	16.8%	18.8%	12.4%	13.4%	5.2%	4.9%	5.7%	8.2%
Alcoa	22.4%	18.8%	1.8%	2.3%	12.1%	9.0%	5.9%	8.0%	6.4%	5.2%	5.9%	12.1%
Altria	16.5%	20.6%	1.5%	2.6%	12.9%	11.1%	5.9%	7.2%	5.9%	4.6%	6.7%	12.1%
American Express	35.3%	33.2%	8.8%	9.8%	13.9%	12.4%	5.7%	8.0%	5.9%	4.9%	4.1%	9.8%
ATT	14.4%	14.7%	1.5%	1.8%	7.7%	7.5%	4.1%	5.7%	6.4%	4.6%	3.1%	2.8%
Boeing	21.6%	21.9%	3.1%	4.1%	11.9%	10.3%	5.9%	7.7%	5.4%	4.6%	5.2%	7.5%
Caterpillar	7.0%	11.1%	0.3%	0.5%	10.3%	8.5%	3.9%	4.9%	5.9%	4.6%	5.2%	9.0%
Citigroup	60.8%	57.2%	30.7%	34.3%	20.6%	17.8%	11.3%	12.6%	6.7%	4.6%	6.7%	10.8%
Coca-Cola	29.6%	31.4%	6.2%	8.8%	13.7%	12.6%	6.4%	7.5%	4.4%	4.9%	5.7%	8.2%
Disney	18.0%	16.2%	1.5%	1.5%	11.1%	9.0%	3.1%	5.7%	4.1%	4.6%	2.1%	3.1%
DuPont	14.9%	16.8%	1.8%	2.3%	10.1%	8.5%	4.9%	5.7%	5.4%	4.6%	5.9%	7.2%
Exxon	18.6%	20.4%	0.5%	2.3%	11.3%	10.1%	5.2%	7.0%	6.2%	4.6%	6.2%	13.4%
GE	28.6%	34.0%	5.9%	9.5%	10.3%	13.4%	4.6%	5.9%	5.2%	4.6%	5.2%	10.3%
Hewlett Packard	16.8%	15.5%	2.8%	4.9%	10.3%	8.5%	5.7%	7.2%	4.4%	4.6%	6.4%	15.5%
Home Depot	27.3%	25.3%	3.6%	5.2%	10.1%	10.1%	3.9%	5.2%	5.9%	4.6%	6.2%	9.3%
Honeywell	19.1%	16.0%	1.5%	1.8%	8.5%	8.0%	2.3%	3.9%	7.0%	4.6%	4.6%	4.1%
IBM	13.4%	12.4%	2.1%	2.3%	5.7%	6.4%	3.4%	4.1%	6.7%	4.9%	3.9%	5.2%
Intel	14.9%	14.4%	1.5%	1.8%	7.2%	7.5%	2.8%	4.6%	5.4%	4.6%	6.2%	13.4%
Johnson & Johnson	14.2%	12.1%	1.3%	1.8%	9.5%	7.5%	4.4%	4.9%	3.6%	4.6%	4.6%	12.4%
JPMorgan	51.0%	50.5%	21.9%	24.7%	14.7%	14.9%	7.2%	6.7%	4.6%	4.6%	6.4%	12.4%
McDonald's	19.3%	16.2%	2.6%	3.1%	7.7%	8.2%	3.4%	4.9%	4.6%	4.9%	3.9%	8.2%
Merck	13.9%	18.8%	1.3%	2.1%	6.4%	9.3%	2.6%	4.4%	7.2%	4.9%	5.4%	8.2%
Microsoft	24.0%	24.2%	4.9%	7.7%	10.1%	9.8%	5.2%	7.7%	6.2%	4.6%	5.4%	9.5%
Pfizer	8.0%	14.9%	0.8%	1.0%	10.3%	11.6%	5.2%	6.7%	5.2%	4.6%	4.6%	5.2%
Procter & Gamble	18.8%	17.5%	1.8%	2.1%	11.9%	9.3%	4.9%	6.4%	6.2%	4.6%	5.9%	10.6%
United Technologies	17.3%	18.3%	1.5%	1.5%	11.3%	11.3%	4.1%	5.9%	5.4%	4.9%	4.6%	6.2%
Verizon	14.9%	11.9%	1.8%	2.1%	9.0%	8.2%	4.1%	4.9%	5.2%	4.9%	5.7%	8.2%
Wal-Mart	21.4%	18.3%	2.3%	4.1%	9.0%	9.8%	4.9%	7.2%	6.4%	5.2%	5.9%	12.1%
Mean	22.8%	23.1%	5.3%	6.4%	10.8%	10.3%	5.0%	6.5%	5.5%	4.7%	5.1%	8.8%
Standard Deviation	13.9%	13.6%	9.1%	9.3%	3.1%	2.9%	2.3%	2.2%	1.0%	0.1%	1.3%	3.3%

The results in Table 3 offer several immediate insights. First, when conducting event studies over periods with significant time-varying changes in market volatility, using an estimation window with data separated in time

from the event date will lead to biased results. Averaging over the sample securities, the standard OLS- and SQ-test-based market models reject the null hypothesis of no abnormal performance more than four times as often as they should, considering the confidence level attached to the test. Even for the alternative models where average rejection frequencies are functionally equivalent to the test standard, variance in the rejection frequencies is too large for reliable inference. For instance, using the VIX-adjusted OLS market model with a pre-period estimation window, the average rejection frequency is 5.3%. However, within that sample there are three securities with a null rejection rate over 20% and four with less than 1%.

Even using the better-specified rolling window estimation period, standard OLS- and SQ-test-based models reject the null hypothesis two times as often as they should. This is ostensibly surprising; according to Gelbach, "[t]he SQ test's asymptotic Type I error rate always equals the analyst's desired significance level."[221] There are several likely reasons for my inconsistent empirical findings. First, instead of using contiguously dated estimation periods in testing their model, Gelbach et al. use a Monte Carlo simulation to randomly select one hundred observations from a seven-year period.[222] If there is a *time-varying* component of market volatility, it will likely be eliminated by randomly selecting dates from a multiyear window. Additionally, their dataset consists of the returns on all securities listed in the CRSP database from 2000 to 2007.[223] In light of the results in Table 2, model choice may not have an effect on inference properties when analyzed over the interlude between two financial market crashes. Although the SQ test may be a reliable statistical method in narrowly described conditions, event studies conducted for securities litigation do not use random samplings or select returns over a seven-year period to generate the estimation period. As a result, even if the SQ test creates asymptotically defined error rates in the abstract, it does not appear to provide a practical advantage over the standard OLS market model when adapted to the necessities of securities fraud class actions.

Using in-sample estimation resolves the issue of overrejection for all risk-adjustment procedures except for FGLS, which has elevated levels of statistically significant results with higher variance.[224] When using a sampling

221. Gelbach et al., *supra* note 120, at 533.

222. *Id.* at 521.

223. *Id.* at 505.

224. Although this could also be an artifact of events in the data, some have found a tendency to falsely reject the null hypothesis when using FGLS in other contexts. *See, e.g.*, Aman Ullah & Xiao Huang, *Finite Sample Properties of FGLS Estimator for Random-Effects Model Under Non-Normality*, *in* PANEL DATA ECONOMETRICS: THEORETICAL CONTRIBUTIONS AND EMPIRICAL APPLICATIONS 67, 83 (Badi H. Baltagi ed., 2006) (finding

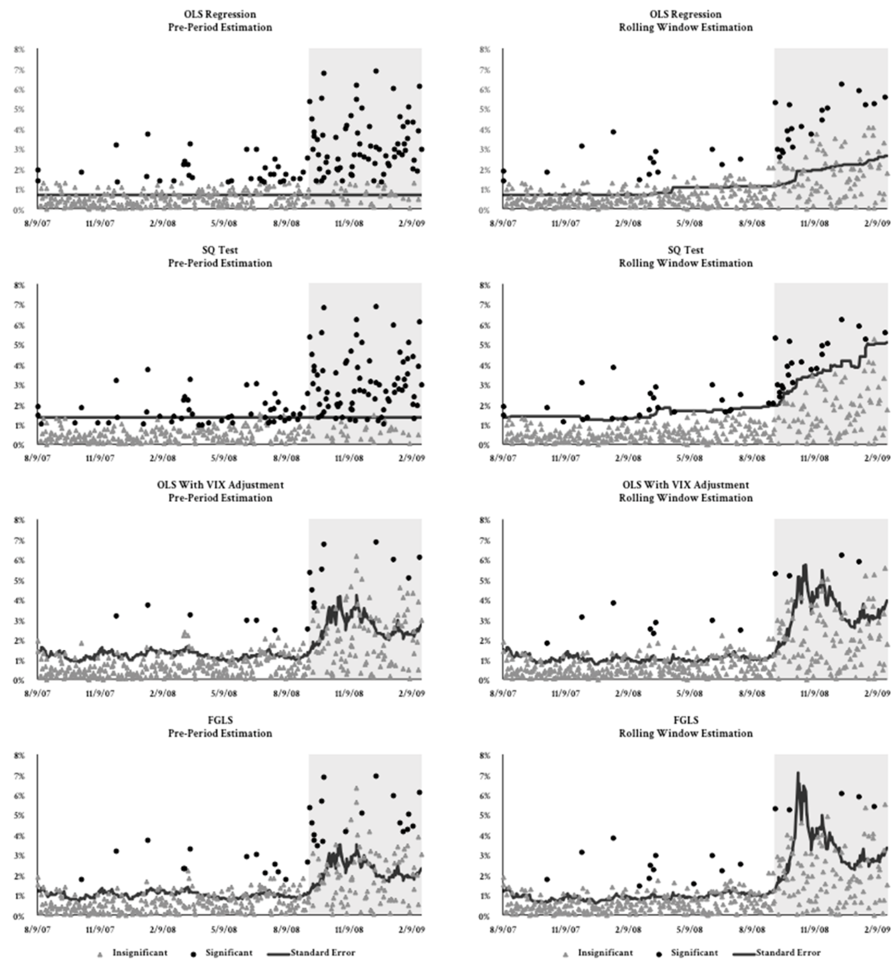
footnote continued on next page

window encompassing the entire event period, any deviation from the desired error rate will be the result of idiosyncratic deviations in the shape of the return distribution, not a result of changes in market volatility. However, given the exigencies of litigation, courts are unlikely to allow expert testimony to use postevent return data to explain the variation in security returns surrounding dates of misrepresentation or corrective disclosure. Table 3 suggests this is not necessary; it is possible to obtain statistically robust results by using a volatility-corrected event study and a rolling window estimation period. Graphical depiction allows for a more complete understanding of the ability of the models to isolate abnormal performance and statistical significance. Figure 4 displays the abnormal returns and variance estimates for General Electric[225] over the financial crisis period.

the use of FGLS in the presence of non-normal time-varying errors in a random-effects panel-data model to cause overrejection of the null hypothesis).

225. While General Motors is an admittedly arbitrary choice, the general pattern exhibited in Figure 4 is similar regardless of security chosen. Charts for other securities are available upon request.

Figure 4
Abnormal Returns over the Financial Crisis Period by Model and Estimation Window



The left and right panels of Figure 4 present the abnormal return series for pre-period and rolling window event studies, respectively. Light triangles represent statistically insignificant abnormal returns, dark circles represent statistically significant abnormal returns, the bolded line indicates the daily root mean standard error used to calculate the *t*-statistic, and the gray shaded area indicates the portion of the event period following the collapse of Lehman

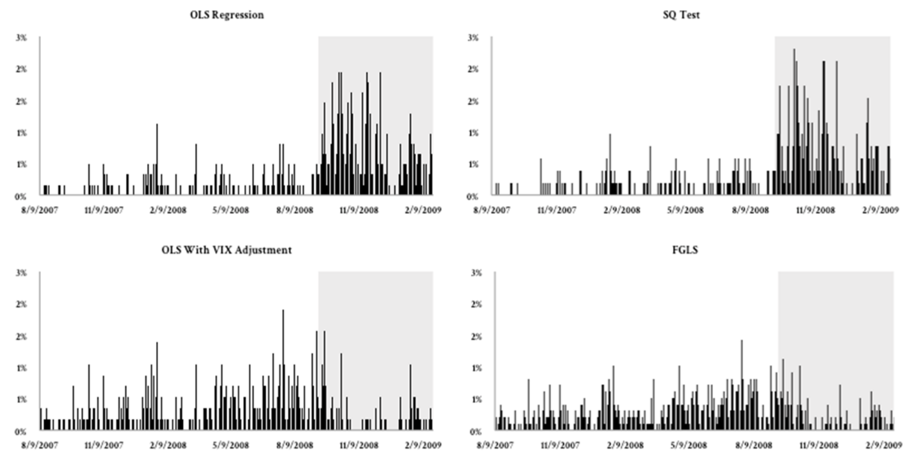
Brothers.[226] As previously demonstrated through tabular results, pre-period estimation and standard models result in excess null rejections. Figure 4 also demonstrates that not only are there too many statistically significant abnormal returns, but they are also clustered in the latter, more volatile portion of the crisis period.

Additionally, Figure 4 demonstrates that this discrepancy in the number of statistically significant rejections in the two phases of the crisis period exists with rolling window uncorrected event studies as well. The improved performance in models incorporating a market proxy is largely a result of the sensitivity of the standard error estimate used to calculate significance. The bolded lines representing the variance of the abnormal returns for the VIX-adjusted and FGLS models increase more rapidly, and to a greater extent, than do those in the standard OLS market model or the SQ test. Accordingly, when return variance increased drastically following the collapse of Lehman Brothers, the abnormal return calculations failed to reflect the total effect of extrinsic volatility. The standard error estimates for the unadjusted models increased slowly and took longer to revert once the market panic subsided. This latter point is significant because it indicates that a properly adjusted event study has the potential to benefit plaintiffs or defendants, depending on where the relevant abnormal return is situated in relation to changes in market volatility. For returns occurring *after* a period of excess volatility, the unadjusted event studies will have a higher standard error and less sensitive *t*-statistics than the corrected models.

This raises an interesting issue often overlooked in the comparative methodology literature: in addition to finding rejection frequencies approaching asymptotic values in the aggregate, we are also concerned with isolating the *right* statistically significant abnormal returns. Not only do the VIX-adjusted and FGLS market models have lower rejection frequencies, but their statistically significant abnormal returns are spread more evenly across the event period, a result expected with normally fluctuating return series. Figure 5 presents another means of evaluating this concern. To compare across models with similar rejection frequencies, the charts in Figure 5 refer solely to the in-sample estimation window models, which have more comparable rejection rates. Aggregating across the twenty-nine securities, each bar represents the percentage of statistically significant returns per day as a percentage of the total number of statistically significant returns during the crisis period. This transformation permits an untainted comparison of the distribution of excess returns over time and across models.

226. The SQ test does not use a standard error to calculate its test statistics. Instead, the bolded line represents the average of the absolute value of the 2.5th- and 97.5th-percentile abnormal returns. The level cannot be directly compared to parametric-based models, but the change in value reflects a common trend.

Figure 5
Relative Occurrence of Abnormal Returns over the Financial Crisis by Model



Standard OLS and SQ test market models result in noticeable clustering of statistical significance in the more volatile portion of the crisis period. Meanwhile, the adjusted event study models in the lower panel of Figure 5 have null rejections distributed consistently across the period. If we were to assume that fraudulent misstatements occur through time with equal probability, then volatility-controlled market models will be more precise in determining statistical significance. Taken together, these results suggest that event study specification during the crisis period is improved with rolling window event studies and models controlling for changes in market volatility.

B. Type II Error, Power Test

I next use an analysis that imputes artificial negative abnormal performance and tests the ability of competing models to detect the imposed excess return to compare the power properties across models. Historically, tests of statistical power have used simulation analysis to distribute the artificial performance randomly across date-security combinations.[227] When used to compare cross-sectional event studies, which include multiple securities, this approach is necessary due to the sheer number of possible combinations.[228]

227. *See, e.g.*, Brown & Warner, *supra* note 4, at 6.

228. For example, in our context there are 29 securities in our sample and 388 trading dates in the financial crisis period. To capture each date-security combination in a cross-sectional event study would require 388^{29} separate event studies for each level of abnormal performance.

However, such a constraint is not present in the context of single-firm, single-event studies—here, each level of abnormal performance has only 388 potential trading dates and twenty-nine securities. Any attempt to simulate the occurrence of the artificial return will only subtract precision from an analysis that tests each date for each firm. Thus, for every security, date, and model combination, the analysis subtracts increasing levels of artificial abnormal return performance and determines the statistical significance of the return using a one-tailed hypothesis test. Table 4 presents the percentage of statistically significant rejections averaged across models.

Table 4

	Rejection Frequencies (1% Abnormal Return)		
	Pre-Period	Rolling Window	In-Sample
Standard OLS	36.6%	24.5%	10.7%
SQ Test	42.9%	29.5%	13.2%
VIX-Adjusted OLS	9.9%	14.1%	15.5%
FGLS	12.5%	18.0%	22.9%
	Rejection Frequencies (2% Abnormal Return)		
	Pre-Period	Rolling Window	In-Sample
Standard OLS	66.7%	54.1%	30.1%
SQ Test	71.7%	59.2%	35.2%
VIX-Adjusted OLS	27.4%	38.3%	39.2%
FGLS	33.9%	45.1%	49.8%
	Rejection Frequencies (3% Abnormal Return)		
	Pre-Period	Rolling Window	In-Sample
Standard OLS	85.2%	75.3%	57.3%
SQ Test	87.5%	78.5%	62.4%
VIX-Adjusted OLS	50.4%	61.1%	60.7%
FGLS	57.2%	67.3%	69.0%
	Rejection Frequencies (5% Abnormal Return)		
	Pre-Period	Rolling Window	In-Sample
Standard OLS	96.6%	92.6%	84.7%
SQ Test	97.1%	93.5%	86.8%
VIX-Adjusted OLS	78.3%	84.4%	82.0%
FGLS	82.1%	87.8%	86.1%
	Rejection Frequencies (10% Abnormal Return)		
	Pre-Period	Rolling Window	In-Sample
Standard OLS	99.6%	98.5%	95.8%
SQ Test	99.6%	98.7%	97.1%
VIX-Adjusted OLS	96.9%	96.7%	95.7%
FGLS	97.8%	97.3%	97.1%

These results reflect the tradeoff between asymptotic size (the Type I error rates found in Table 3) and power (the Type II error rates found in Table 4) that often accompanies tests of inference. As Gelbach et al. note, controlling for the probability that a test incorrectly rejects the null hypothesis can also cause the test to fail to reject the null when it is in fact false.[229] As a result, standard models, which had rejection rates under no abnormal performance considerably higher than those predicted by the significance level of the hypothesis test, are more capable of detecting abnormal performance than the VIX-adjusted or FGLS models. This again is intuitively unsurprising; if standard models overreject the null hypothesis without imputed abnormal performance, they are likely to reject it at a higher rate when abnormal performance is present. Additionally, for all levels of artificial abnormal performance and for each choice of estimation period, the FGLS market model has more statistical power than the VIX-adjusted OLS model. As mentioned in the methodological explanation, this follows from the theory underlying the volatility correction. FGLS event studies more accurately detect abnormal performance because they apply the correction according to the sensitivity of each security to changes in market volatility. The VIX-adjusted OLS model, on the other hand, assumes that changes in VIX affect each security equally, causing under- and overcorrection depending on the stock's sensitivity.

Table 4 further demonstrates that rolling window event studies are more powerful than other volatility-corrected models, but the difference in performance narrows as the size of the imputed abnormal performance increases. This is an encouraging result because the statistical power in tests with a sample of one is generally low.[230] It is not obvious that a model should be expected to detect 1% abnormal performance given the level of variance in individual security returns in modern financial markets. At 3% abnormal return or higher, the discrepancy is manageable. Thus, a court facing a choice between models must weigh competing demands and sacrifices between power and precision, along with the disparate effects each would have on parties to the suit.

C. Robustness Check with S&P 500 Data

There is always a possibility that the increase in rejection frequency over this period is a result of firm-specific events and not exogenous market effects. If this were true, the assumption that rejection rates should converge to the size of the test is invalid. By not accounting for genuine events in the data series, the abnormal return distribution may be more or less normal than if the

229. Gelbach et al., *supra* note 120, at 498.

230. Sanjai Bhagat & Roberta Romano, *Event Studies and the Law: Part I; Technique and Corporate Litigation*, 4 AM. L. & ECON. REV. 141, 149 (2002).

abnormal returns of actual events were accounted for.[231] To ensure that these analyses were not isolating spurious results, I compared the results to those derived from a larger set of securities.

With this concern in mind, the returns of the underlying securities in the S&P 500 were evaluated over the financial crisis period. With a broad cross-section of securities across industry groups, it is reasonable to assume that the true error rate should be the size of the confidence test because, for any given security, it is just as likely that there will be fewer "events" in a certain period than more. When the size of the sample increases with additional securities, the potential departure from the asymptotic error rate is diversified away.

In constructing the sample set, the S&P 500 constituents were first downloaded from the Compustat database, a division of S&P Capital IQ. All historical constituents that entered the Index after August 9, 2007 or were removed from the Index before February 23, 2009 were excluded. The resulting set consisted of all securities that were a part of the Index over the entirety of the crisis period. Using the ticker symbols in the Compustat dataset, individual security returns were downloaded from the CRSP Daily Stock File archive. Duplicates from dual-listed shares and all return series lacking complete data for the full year prior to the estimation period were removed, resulting in a total of 418 stocks in the sample. Table 5 reports the average rejection frequency across securities using a two-tailed test and a 95% confidence level.

Table 5
Rejection Frequencies—Financial Crisis Period

	Pre-Period	Rolling Window	In-Sample
Standard OLS	22.5%	10.3%	5.3%
SQ Test	22.6%	9.9%	4.6%
VIX-Adjusted OLS	4.4%	4.7%	5.1%
FGLS	5.1%	6.0%	9.1%

The findings in Table 5 are nearly identical to the aggregated results presented in Table 3 for the Dow 30 companies. This evidence strengthens the conclusion that the overrejection of the null hypothesis prevalent during the financial crisis is a result of exogenous market factors common to all securities and is not the result of firm-specific events present in a smaller sample of Dow Index stocks.

231. *See* Ford & Kline, *supra* note 180.

Conclusion

Heightened judicial review of expert evidence in securities fraud cases will not require a new procedural framework—flawed event studies already violate the established standard for admissibility outlined in *Daubert v. Merrell Dow Pharmaceuticals, Inc.*[232] In *Daubert*, the Supreme Court relaxed the *Frye* "general acceptance" standard that governed for most of the twentieth century and required academic consensus for expert testimony provided to courts.[233] In exchange for broadening the scope of admissibility, the Court reinforced the historical "gatekeeping role" of the judiciary in filtering evidence provided to the jury[234] and handed down a set of considerations for judicial review—namely that the evidence provided relate to the issue in the case, that the expert be qualified to testify on the subject at hand, and that the proposed testimony be "supported by appropriate validation."[235]

Under the last prong, trial courts are now instructed to "examine the methodologies and principles underlying proffered expert testimony to determine whether those principles and methods are sufficiently valid to admit."[236] The *Daubert* Court provided that in evaluating the basis for testimony, judges might consider "whether it can be (and has been) tested,"[237] whether it "has been subjected to peer review and publication,"[238] the "*known or potential rate of error*" of the scientific technique,[239] and its degree of "general acceptance."[240] A recent study found that judicial error-rate analysis is common and is strongly predictive of admissibility decisions,[241] suggesting that courts may find such an attack in this context persuasive. Although courts are led to believe that a confidence level attached to an event study test corresponds to a known error rate, empirical evidence of deviations from normality indicates that there is often an actionable claim to the contrary.

232. 509 U.S. 579 (1993).

233. *See* Lawrence B. Ebert, Frye *After* Daubert*: The Role of Scientists in Admissibility Issues as Seen Through Analysis of the DNA Profiling Cases*, 1 U. CHI. L. SCH. ROUNDTABLE 219, 219, 224 (1993).

234. *Daubert*, 509 U.S. at 597.

235. David L. Faigman, *The* Daubert *Revolution and the Birth of Modernity: Managing Scientific Evidence in the Age of Science*, 46 U.C. DAVIS L. REV. 893, 902-03 (2013) (quoting *Daubert*, 509 U.S. at 590).

236. *Id.* at 903.

237. *Daubert*, 509 U.S. at 593.

238. *Id.*

239. *Id.* at 594 (emphasis added).

240. *Id.*

241. John B. Meixner & Shari Seidman Diamond, *The Hidden* Daubert *Factor: How Judges Use Error Rates in Assessing Scientific Evidence*, 2014 WIS. L. REV. 1063, 1067.

Moreover, judicial reliance on event study analysis is liable to increase in the future. In *Halliburton II*, the Supreme Court declared that defendants are afforded the opportunity to rebut the presumption of reliance prior to class certification by demonstrating a lack of price impact associated with the alleged misrepresentations or omissions.[242] Given that the overwhelming majority of securities fraud suits settle following certification, bringing the issues of price impact and materiality to the certification stage significantly increases the need for statistically reliable results. Although courts have traditionally been inclined to accept the probative value of expert-provided event studies—perhaps due to deference to technical expertise—a reexamination of the statistical foundations of the test is in order. With the merits hinging on the provision of an event study to satisfy the legal predicates for a cause of action, the legal community should ensure that its faith in econometric objectivity is not based on false pretense.

This Note establishes that event study models failing to explicitly correct for the increased variance in security returns will be biased towards finding statistically significant abnormal returns in the presence of a shift in market volatility. This is not merely an interesting exercise in econometric nuance; 206 class actions were tied to the credit crisis, with billions of dollars in potential corporate liability.[243] As a formal condition for a sustained cause of action, an event study was likely proffered in every case that withstood a motion to dismiss.

Although the effect of event study model choice is less pronounced during periods of stable returns, it is precisely during episodes of market volatility that the findings of an event study are most consequential. Courts should be unwilling to cede their adjudicative role in these disputes to the results of an empirical analysis with unknown or unascertained rates of error. While event

242. 134 S. Ct. 2398, 2414 (2014) ("Even if plaintiffs need not directly prove price impact to invoke the *Basic* presumption, Halliburton contends that defendants should at least be allowed to defeat the presumption at the class certification stage through evidence that the misrepresentation did not in fact affect the stock price. We agree.").

243. *See* CORNERSTONE RESEARCH, SECURITIES CLASS ACTION FILINGS: 2014 YEAR IN REVIEW 4 fig.2 (2014). Liability in these suits is hard to measure because nearly all settle or get dismissed. The Cornerstone report uses two measures that proxy for corporate exposure: the maximum dollar loss (MDL) and the disclosure dollar loss (DDL). The MDL measures the dollar-value change in market capitalization of the security as the difference in the maximum value over the class period and the value on the trading date immediately following the end of the class period. *Id.* at 7. The DDL measures the difference in the market capitalization of the security between the trading day immediately prior to the end of the class period and the trading day immediately afterwards. *Id.* at 6. According to Cornerstone's research, the aggregate MDL for credit-crisis-related filings was over $1 trillion, and the more restrictive DDLs were $174 billion. *Id.* at 6-7 figs.4 & 5. The likely aggregate exposure value is somewhere between those two figures.

studies commonly submitted in federal court likely produce biased results, readily available modeling changes can provide more robust statistical inference. Although these models add a level of methodological complexity to the standard approach, courts would be well advised to consider such modification given the considerable financial exposure generated through private securities fraud suits.

Appendix

The following Appendix describes the precise specification used for the four risk-adjustment methodologies used for the substance of this Note. The Stata code used to produce the empirical results is available at http://works.bepress.com/andrew_baker.

A. Standard OLS Market Model

The standard event study model was broadly outlined in Section III above, but below is the methodology as specifically applied to this analysis.

1. Estimate the market model equation:

$$R_{i,t} = \alpha_i + \beta_i(SP500)_t + \varepsilon_{i,t} \qquad (1)$$

where R is the return on the security, i is a unique firm identifier, and t represents the time component.

2. Derive the daily abnormal return:

$$AR_{i,t} = R_{i,t} - \hat{\alpha}_i - \hat{\beta}_i(SP500)_t = \partial_{i,t} \qquad (2)$$

3. Calculate the t-statistic for each abnormal return:

$$tstat_{i,t} = \frac{AR_{i,t}}{SD_i} \qquad (3)$$

where SD_i is the root mean squared error from the equation in (1):

$$SD_i = \sqrt{\frac{\sum_1^T \partial_{i,t}{}^2}{T-1}} \qquad (4)$$

T is the number of observations in the estimated model.

4. Test the abnormal return for statistical significance:

An abnormal return will be statistically significant at the 95% confidence level if:

a) Two-tailed test:

$$|tstat_{i,t}| \geq tdist(T, \frac{\alpha}{2})$$

b) One-tailed test:

$$Positive\ Test: tstat_{i,t} \geq \text{tdist}(\text{T},\alpha)$$
$$Negative\ Test: tstat_{i,t} \leq tdist(T,\text{-}\alpha)$$

For a two-tailed test and a 95% confidence interval, the null hypothesis of no abnormal return can be rejected if the absolute value of the *t*-statistic is greater than or equal to roughly 1.96. For one-tailed test the critical value is approximately ±1.645 depending on whether you are checking for a positive or negative expected abnormal return.

B. SQ Test

The SQ Test follows the same initial two steps as the standard OLS model, but rather than determining statistical significance through the parametric properties of the t-distribution, it compares the event period abnormal return to the empirical distribution of pre-event fitted excess returns.[1] Following steps one and two above;

1. Sort the abnormal returns from the estimation period from greatest to least:

$$\overline{\overline{AR}}_{(1)} \geq \overline{\overline{AR}}_{(2)} \geq \ldots > \overline{\overline{AR}}_{(T)}$$

2. Determine the statistical significance of the event abnormal return in reference to the sample quantiles implied in (3):

An abnormal return will be statistically significant if:

a. *Two-tailed Test:*

$$AR_{i,t} \geq \overline{\overline{AR}}_{T*\left(\frac{\alpha}{2}\right)} \text{ or } AR_{i,t} \leq \overline{\overline{AR}}_{T*\left(1-\frac{\alpha}{2}\right)}$$

b. *One-tailed Test:*

$$Positive\ Test: AR_{i,t} \geq \overline{\overline{AR}}_{T*(\alpha)}$$
$$Negative\ Test: AR_{i,t} \leq \overline{\overline{AR}}_{T*(1-\alpha)}$$

244. Gelbach et al., *supra* note 120, at 495.

For a two-tailed test and a 95% confidence level with 240 pre-fitted excess returns, the null hypothesis will be rejected if the abnormal return is either greater than or equal to the sixth largest pre-fitted excess return (240*0.025) or less than or equal to the 234^{th} largest pre-fitted excess return (240*0.975). A one-tailed test will reject the null hypothesis if the abnormal return is greater (less) than or equal to the 12^{th} (228^{th}) largest pre-fitted excess return.

C. OLS Market Model with VIX Standard Error Adjustment

The VIX-adjusted OLS market model is in most respects identical to the standard OLS market model with an additional adjustment to the denominator of the *t*-statistic to reflect the difference in the VIX level between the estimation period and the event period. This is a modified version of the model used by Professor Gregg Jarrell as the expert witness for plaintiffs in *In re Countrywide Financial Corporation Securities Litigation*.[2] Following steps (1) and (2) above, along with the root mean squared error from (4):

1. Calculate the daily VIX adjustment factor:

$$Vadj_t = \frac{VIX_t}{\left(\frac{\sum_1^T VIX_t}{T}\right)} \tag{5}$$

which is the ratio of the event date VIX to the average VIX over the estimation window.

2. Calculate the modified *t*-statistic as:

$$tstat_{i,t} = \frac{AR_{i,t}}{SD_i * Vadj_t} \tag{6}$$

3. Test the abnormal return for statistical significance following Step 4 of the standard OLS market model.

D. FGLS Market Model

The FGLS market model follows the underlying intuition of the VIX-adjusted OLS model—if a change in market volatility results in violations of the normality assumption, ignoring it while modeling expected returns will

245. Expert Report of Gregg Jarrell at 32-33, 2010 WL 6681871 (C.D. Cal.) (Mar. 31, 2010). Jarrell used the implied volatility of a set of firms within a constructed peer index rather than the VIX Index to calculate the ratio adjustment. He also uses ratio adjustments based on average volatility levels of sub-periods of the Class Period, whereas this paper calculates a separate adjustment factor for each analyzed trading day.

result in biased inference. FGLS is an attractive alternative to OLS when there is evidence of heteroscedasticity,[3] which causes the standard errors of OLS to become inflated. As a method to model the function of heteroscedasticity with empirical data, FGLS is consistent and asymptotically more efficient than OLS.[4] Using FGLS to adjust an event study for volatility is notionally superior to the ad hoc modification used in the VIX-adjusted OLS market model described in Part IV(B)(3) above. Rather than assuming a constant effect across securities, FGLS allows the adjustment factor to vary across firms depending on the historical relationship between the abnormal returns and the market volatility proxy. However, FGLS is a slightly more complicated statistical procedure, and as such may be more difficult to explain to a judge and jury. The FGLS model has been used by Mukesh Bajaj as an expert witness for the defendants in *In re Federal Home Loan Mortgage Corp. (Freddie Mac) Securities Litigation*.[5] The steps in conducting an FGLS market model are as follows:

1. Estimate the market model equation:

$$R_{i,t} = \alpha_i + \beta_i(SP500)_t + \varepsilon_{i,t} \tag{7}$$

2. Using the residuals from the market model equation, estimate the variance equation:

$${\partial_{i,t}}^2 = \beta_i(VIX_t)^2 + \eta_{i,t} \tag{8}$$

3. Recalculate the market model equation in (7) using weighted least squares, with the weight used being the inverse of the predicted value from the variance equation.

$$R_{i,t} = \alpha_i + \beta_i(SP500)_t + \vartheta_{i,t}$$
$$weight_{i,t} = \frac{1}{(\widehat{\beta_i} * {VIX_t}^2)} \tag{9}$$

246. Heteroscedasticity represents a violation of the assumption that the modelling errors (in the context of an event study, the abnormal return) are uniform and constant across time, which is a predicate for OLS regression. *See* THE SAGE ENCYCLOPEDIA OF SOCIAL RESEARCH METHODS 464 (Michael S. Lewis-Beck eds. 2004).

247. *See* JEFFREY M. WOOLDRIDGE, INTRODUCTORY ECONOMETRICS: A MODERN APPROACH 284 (2006).

248. Expert Report of Mukesh Bajaj at 45, 281 F.R.D. 174 (Aug. 15, 2011). The reader should be aware that I have previously worked with Mukesh Bajaj.

4. Repeat steps 2 and 3 until $\widehat{\alpha_i}$ and $\widehat{\beta_i}$ converge

5. Calculate the t-statistic based on the abnormal return and predicted residuals from (9) and (8) respectively.

$$tstat_{i,t} = \frac{\vartheta_{i,t}}{\sqrt{(\widehat{\ }_i * VIX_t{}^2)}}$$

6. Test the abnormal return for statistical significance following Step 4 of the standard OLS market model.

Exhibit 48

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Campbell R. Harvey
The President of the American Finance Association 2016

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Presidential Address: The Scientific Outlook in Financial Economics

CAMPBELL R. HARVEY*

ABSTRACT

Given the competition for top journal space, there is an incentive to produce "significant" results. With the combination of unreported tests, lack of adjustment for multiple tests, and direct and indirect p-hacking, many of the results being published will fail to hold up in the future. In addition, there are basic issues with the interpretation of statistical significance. Increasing thresholds may be necessary, but still may not be sufficient: if the effect being studied is rare, even $t > 3$ will produce a large number of false positives. Here I explore the meaning and limitations of a p-value. I offer a simple alternative (the minimum Bayes factor). I present guidelines for a robust, transparent research culture in financial economics. Finally, I offer some thoughts on the importance of risk-taking (from the perspective of authors and editors) to advance our field.

SUMMARY

- Empirical research in financial economics relies too much on p-values, which are poorly understood in the first place.
- Journals want to publish papers with positive results and this incentivizes researchers to engage in data mining and "p-hacking."
- The outcome will likely be an embarrassing number of false positives—effects that will not be repeated in the future.
- The minimum Bayes factor (which is a function of the p-value) combined with prior odds provides a simple solution that can be reported alongside the usual p-value.
- The Bayesianized p-value answers the question: What is the probability that the null is true?
- The same technique can be used to answer: What threshold of t-statistic do I need so that there is only a 5% chance that the null is true?
- The threshold depends on the economic plausibility of the hypothesis.

LET ME START WITH AN ORIGINAL EMPIRICAL EXAMPLE. Some of you are familiar with my work on identifying factors. Consider a new factor that is based on equity returns from CRSP data. The t-statistic of the long-short portfolio is 3.23,

*Campbell R. Harvey is with Duke University and the National Bureau of Economic Research. I appreciate the comments of Manuel Adelino, Geert Bekaert, Jim Berger, Alon Brav, Anna Cieslak, Wayne Ferson, David Hirshleifer, Jay Im, Ben McCartney, Stefan Nagel, Brenda Priebe, Emmanuel Roman, Stephan Siegel, Michael Stutzer, Joy Tong, and Ivo Welch. I am especially grateful to Yan Liu for comments on many versions of this paper. Jay Im and Jane Day provided research assistance.

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which exceeds the Harvey, Liu, and Zhu (HLZ; 2016) recommended threshold of 3.00. The factor has a near-zero beta with the market and other well-known factors, yet an average return that comfortably exceeds the average market excess return. What is this factor?

Here are the instructions that I gave my research assistant: (1) form portfolios based on the first, second, and third letters of the ticker symbol; (2) show results for 1926 to present and 1963 to present; (3) use a monthly, not daily, frequency; (4) rebalance portfolios monthly and once a year; (5) value weight and equally weight portfolios; (6) make a choice on delisting returns; and (7) find me the best long-short portfolio based on the maximum t-statistic.

There are 3,160 possible long-short portfolios based on the first three letters of the tickers. With two sample periods, there are 6,320 possible portfolio choices, equal and value weights bring this number to 12,640, and two choices for reconstituting the portfolio doubles this number again. In short, there are a huge number of choices.

Many would argue that we should increase the choice space further because there are other possible choices that I did not give to my research assistant. Suppose, for instance, there are three ways to handle delisting returns. Ex ante, one was chosen. The argument is that we should consider the fact that, hypothetically, we could have had three choices, not just the one chosen (see Gelman and Loken (2013)).

It is not surprising that, under a large enough choice set, the long-short strategy has a "significant" t-statistic—indeed, dozens of strategies have "significant" t-statistics. This is an egregious example of what is known as p-hacking.

One might think this is a silly example. But it is not. A paper referenced in the HLZ (2016) factor list shows that a group of companies with meaningful ticker symbols, like Southwest's LUV, outperform (Head, Smith, and Watson (2009)). Another study, this time in psychology, argues that tickers that are easy to pronounce, like BAL as opposed to BDL, outperform in IPOs (Alter and Oppenheimer (2006)). Yet another study, in marketing, suggests that tickers that are congruent with the company's name outperform (Srinivasan and Umashankar (2014)). Indeed, some have quipped that ETF providers such as Vanguard might introduce a new family of ETFs called "AlphaBet" with each ETF investing in stocks with the same first letter of a ticker symbol.

Many interpret HLZ (2016) as suggesting that we "raise the threshold for discovering a new finding to $t > 3$." However, the point of that paper is that many in our profession (including myself) have been making an error in not adjusting thresholds for multiple tests. *In this address, I emphasize that making a decision based on* $t > 3$ *is not sufficient either*. In particular, raising the threshold for significance may have the unintended consequence of increasing the amount of data mining and, in turn, publication bias. Journals contribute to data mining through their focus on publishing papers with the most "significant" results. The reason is that journal editors are often competing for citation-based impact numbers. Indeed, if you go to the American Finance Association's homepage, you will see the *Journal of Finance*'s impact factor prominently displayed. Because papers that do not report "significant" results generate fewer citations

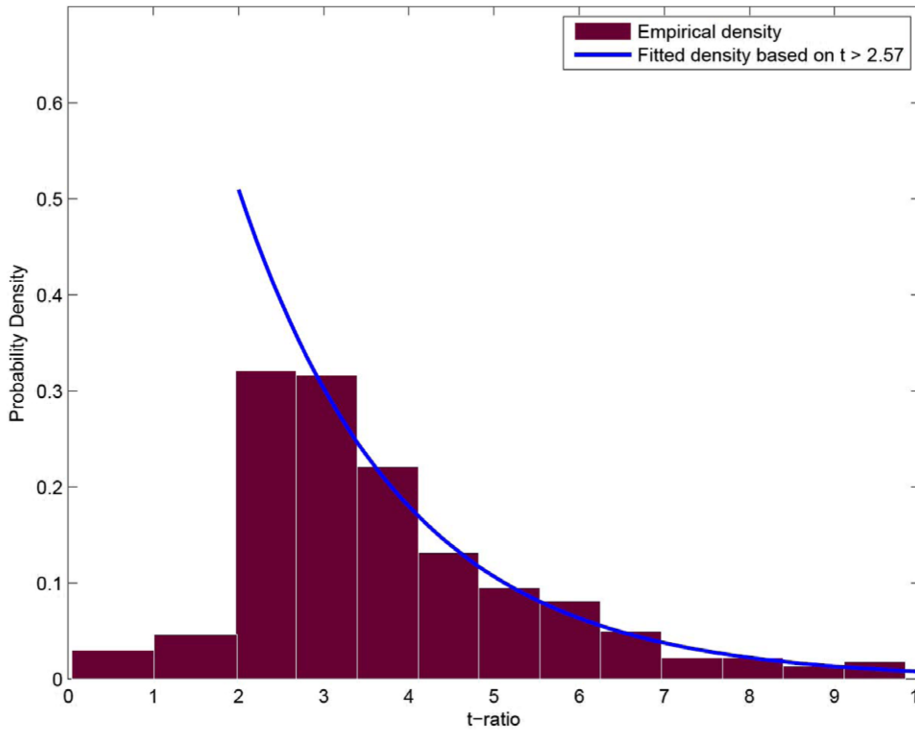

Figure 1. Distribution of reported *t*-statistics from factor studies, 1963 to 2012. Evidence from Harvey, Liu, and Zhu (2016).

(Fanelli (2013)), these papers are less likely to be published. This leads to publication bias, whereby readers see only a select sample of the actual research conducted.

Researchers also contribute to publication bias. Knowing journals' preference for papers with "significant" results, authors may not submit papers with "marginal" results. Such bias is known in other sciences as the "file drawer effect"—research is filed away rather than submitted to a journal (Rosenthal (1979)). Publication bias may also be induced by authors cherry-picking the most significant results (*p*-hacking) to submit to a journal. And even if journals were willing to publish papers with marginal or negative results, many authors may file away a research project because they do not want to spend their valuable research time on a paper they are not excited about.

Evidence of publication bias is starkly presented in HLZ (2016), who conduct a meta-analysis of factor studies published in top journals over the period 1963 to 2012. Based on their evidence, Figure 1 shows that the number of studies reporting *t*-statistics in the range of 2.0 to 2.57 is almost the same as the number reporting in the range of 2.57 to 3.14—which only makes sense if there is publication bias. Also, notice that very few papers with negative results (*t*-statistic less than 2.00) are published.

To summarize, researchers in our field face a complex agency problem. Ideally, our goal is to advance knowledge in our field of financial economics. As I show below, editors overwhelmingly publish papers with positive results. Realizing this, many authors believe that a necessary condition for publication is to obtain a positive "significant" result. This belief may lead authors to avoid certain projects, for example, those that involve time-intensive data collection, because they judge the risk to be too high. But these risky projects are exactly the type of initiatives that should be encouraged because they are often the ones that advance our knowledge the most.

In this address, I take a step back and examine how we conduct our research. Unfortunately, our standard testing methods are often ill-equipped to answer the questions that we pose. Other fields have thought deeply about testing. I share some of their insights in Section I. In Section II, I trace the history of the p-value and detail the American Statistical Association's six principles on the use of p-values. In Section III, I describe p-hacking and its detection. In Section IV, I discuss the problem of rare effects and how they impact our inference, and in Sections V and VI, I present a Bayesian perspective on hypothesis testing. I propose a simple Bayesian alternative that essentially involves a transformation of the usual p-value in Section VII, and I detail the limitations of this approach in Section VIII. In Section IX, I outline a set of best practices as well as offer recommendations designed to strengthen our research culture and encourage more risk-taking when making research and publication decisions. I offer concluding remarks in Section X.

I. Evidence from Other Fields

In contrast to financial economics, active research programs in other fields analyze how research is conducted. Many of these studies look across disciplines. For example, Fanelli (2010) studies how likely it is to get published in different fields with results that do not support the main hypothesis developed in the paper (see Figure 2).

Notice that journals in the Space Science field have little problem publishing articles that do not support the main hypothesis, while at the bottom of the list is the field of Psychology. The Economics and Business field is not that far away from Psychology.

The problem is more serious, however, than this snapshot in time suggests. Across all sciences, there is a distinct time trend as also detailed by Fanelli (2012). For example, in 1990, only 70% of papers in social sciences reported positive results but this proportion grows to 90% by 2007. Figure 3 shows that similar trends are evident in the physical and biological sciences.

So why do we see this pattern? Fanelli (2010) links it to Auguste Comte's (1856) famous Hierarchy of Science, with mathematics and astronomy on top and sociology on the bottom. As you move down the hierarchy, complexity increases and the ability to generalize results decreases. Fanelli uses the "hard" and "soft" classification. In the hard sciences, the results speak for themselves and are highly generalizable. In soft sciences, findings could depend

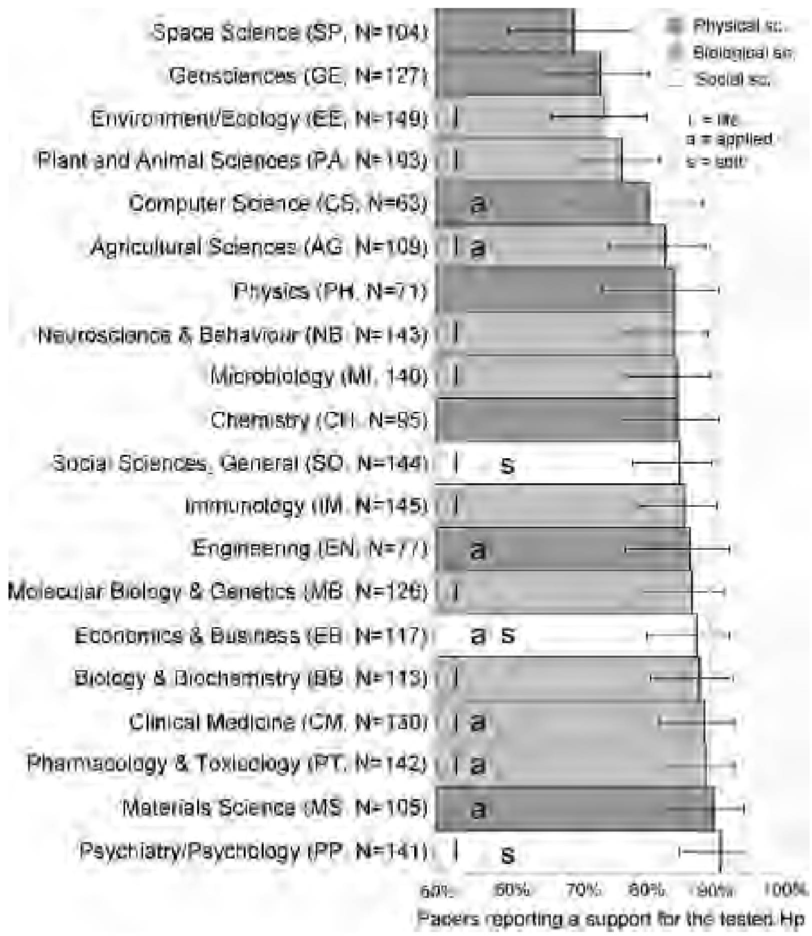

Figure 2. Percent of research papers reporting support for the tested hypothesis by field. Source: Fanelli (2010).

on the researcher's prestige in the community, political beliefs, and personal preferences—all of which could be important in selecting the hypotheses to be tested, the data to be collected, and the methods used in analyzing and interpreting the data—and are often too specific to generalize. A high-profile example of a hard scientific endeavor was the search for the Higgs boson. Importantly, "soft" does not mean "bad" and "hard" does not mean "good." Indeed, Comte (1856) considered sociology, which today would encompass economics and psychology, as "the principal band of the scientific sheaf."[1] Part of the complexity stems from the challenge in interpreting results when the human researcher interacts with the results. This interaction does not play much of a role in the hard sciences but can be impossible to avoid in the soft sciences.

[1] See Comte (1856, p. 457).

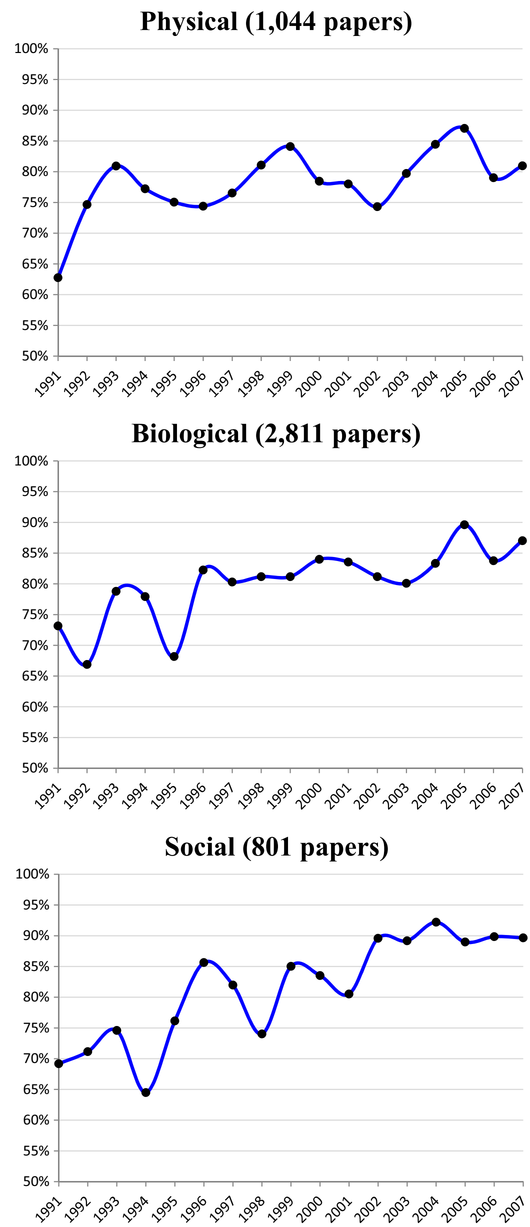

Figure 3. "Positive" results increase over time in the science literature. Data from Fanelli (2012).

Returning to the Hierarchy of Science, why is it that most empirical articles published in economics and finance "support" the idea being tested? Here, I consider possible explanations proposed by Fanelli (2010) in the context of our field.

(1) *We have better theories in financial economics than, say, in particle physics*. This seems unlikely.
(2) *By observing phenomena, we have better prior beliefs in financial economics than in other scientific fields where priors are diffuse because there may be no direct or indirect observation*. This is a credible explanation given that researchers in our field accumulate knowledge over time about how markets work, and this knowledge often forms the basis for new theories or hypothesis tests. However, despite the importance of prior beliefs in financial economics research, they are often not taken into account in standard hypothesis tests, which impacts the way we interpret statistical evidence. I elaborate on this point below.
(3) *In financial economics, the hypotheses tested are often narrow and focused*. This also is a credible explanation. Compare, for example, the conclusion that the Higgs boson is a "central part of the Standard Model of particle physics that describes how the world is constructed" (Royal Swedish Academy of Sciences (2013)) to the hypothesis that companies with smaller boards of directors outperform or the hypothesis that stock returns are higher in January than in other months of the year. A narrower hypothesis may have a better chance of being supported when taken to the data.
(4) *The connection between theories, hypotheses, and empirical findings is more flexible in financial economics*. We have all seen theories tested where choices are made. Perhaps the most fundamental theory in finance is the Sharpe (1964), Lintner (1965), and Mossin (1966) Capital Asset Pricing Model. Many choices are made for testing. For example, what is included in the market portfolio? Do we test on U.S. or international assets? Does the theory apply to equities or all assets? What is the sample period? Should we test using portfolios or individual assets? Should risks be constrained to be constant? Are risk premiums constant? This is much different from flipping a 4 TeV switch, collecting trillions of new observations from the Large Hadron Collider, and searching for a specific particle decay signature as in the quest for the Higgs boson.
(5) *It is more likely that there are interaction effects between the researcher and the effect being researched*. This is a serious problem in experimental and survey-based research in economics and finance as well as other social sciences like psychology. For example, experimental subjects might be aware of the researchers' hypotheses and change their behavior. Another version of this problem involves confirmation bias in how the researcher interprets noisy data. While confirmation bias has been documented in many fields, it is most prevalent in behavioral research (Marsh and Hanlon (2007)).

(6) *Manipulation of the data and results*. Outright fraud is likely minimal in our field as most studies are conducted using data such as CRSP and Compustat that are readily available to other researchers (in contrast to, say, experimental fields, where the researcher creates the data for the study). However, the growth in the number of papers that use proprietary data decreases the probability of being caught and, in turn, the effective cost of fraud. In addition, many empirical design choices may be crucial for the results. For example, what should we include in the sample? Should the data be winsorized and, if so, at what level? Should certain outliers be discarded? Should the data be scaled by another variable? How many control variables should be included? What instruments should be used? Which estimation method should be used? These and similar choices are all tools of the p-hacker.

(7) *A lack of a replication culture*. In other fields, replication studies are published in top journals and often invalidate previous results (i.e., they present a negative result with a new experiment or new data set). In financial economics, in contrast, because much of the data are widely available to researchers (e.g., CRSP and Compustat), replication studies are less interesting and thus are rarely featured in top journals.

(8) *It is hard to publish findings that do not "support" the hypothesis being tested*. It is well-documented that editors and reviewers are more likely to reject negative findings that do not support the hypothesis tested in the paper (Song et al. (2000)). Research shows that papers with "significant" results receive more citations (Fanelli (2013)). This pattern can influence the way people conduct research. Above I discuss a striking truncation of marginally significant or insignificant results in top journals. One danger is HARKing (Hypothesizing After the Results are Known) (Kerr (1998)). Essentially, you have a theory that Y should be correlated with $X1$. You test that theory and include controls $X2$ to $X20$. You find no correlation between Y and $X1$, but you find a correlation between Y and $X7$. You then change the theory and throw $X1$ in with the control variables. HARKing is most likely to occur when it is relatively easy to run an experiment, for example, a regression that uses Computstat data as opposed to an experiment that requires over $5 billion in funding to construct the Large Hadron Collider (CERN (2017)).[2]

In short, the vast majority of papers published in financial economics provide "support" for the theory or hypothesis being tested for a variety of reasons. Some of these reasons are unavoidable, such as narrow hypotheses and the influence of prior information. However, it may be possible to minimize some of the other causes, such as p-hacking.

In an effort to address this issue, I begin by taking a step back. There is a reason I put the word "support" in quotations when referring to papers that present results that "support" the proposed theory or hypothesis: the traditional

[2] See CERN (2017, p. 17). See also https://press.cern/backgrounders/facts-figures.

hypothesis testing framework is unable to tell researchers the probability the hypothesis is true.

II. Understanding the *P*-value

The idea of using a *p*-value for hypothesis testing was introduced by Fisher (1925). His idea is to objectively separate findings of interest from noise. The null hypothesis is usually a statement of no relation between variables or no effect of an experimental manipulation. The *p*-value is the probability of observing an outcome or a more extreme outcome if the null hypothesis is true.

Goodman (1993) provides an excellent review of the history of the *p*-value, which I draw upon here. Fisher's approach focuses on measuring the strength of the evidence against the null hypothesis. He refers to the *p*-value as a "significance probability," that is, the probability of observing data as least as extreme as the actual outcome when the null hypothesis is true: if the *p*-value is less than a threshold of say 5%, the test rejects the null hypothesis. In Fisher's original framework, the *p*-value is not interpreted as the frequency of error if the experiment is repeated. Rather, it applies only to the data used in the test. This is a crucial philosophical point—because this approach applies only to the data under examination, inferences based on this approach may not generalize. Importantly, Fisher argues that the *p*-value should be used in conjunction with other types of evidence when available.

As I explain in more detail below, the most basic mistake in using *p*-values is to assume that a test with a *p*-value of 5% implies that there is only a 5% chance that the null hypothesis is true. This is a mistake because a *p*-value is calculated under the assumption that the null hypothesis is correct.

Neyman and Pearson (NP 1933) provide a different (and incompatible) framework that compares two hypotheses, the null and the alternative. Notice that in the original Fisher framework, there is no alternative hypothesis. NP introduce the idea of a Type I error (false positive rate, or rejecting the null when the null is true) and a Type II error (false negative rate, or failing to reject the null when the alternative is true). Their method focuses on a behavior or a decision-making rule, for example, rejecting the null and accepting the alternative, based on the observed data. In this framework, the (false positive) error rate, α, is set based on the particular experimental situation before the test is conducted (e.g., calibration of an instrument designed to find defects in the manufacturing process).[3] The researcher then reports whether the test falls

[3] The error rate is formally known as the "size" of the test. However, the term "size" has at least two ambiguities: it can be confused with the sample size and it can be confused with the magnitude of the effect. Hence, I prefer not to use the term. The error rate is also sometimes referred to as the significance level, but there is a subtle difference between the significance level and the error rate. The significance level is the *p*-value threshold used to reject a null. The error rate is the level of Type I error observed in following a particular testing procedure. For example, in small samples we can still follow the $t = 2.0$ rule. We would reject the null if the *p*-value implied by a normal distribution is below 5%. In this case, the significance level would be 5%. However, the actual error rate for the test would be higher than 5% since in small samples the normal approximation to a *t*-statistic is inaccurate. In this example, the significance level would be different from the error

into the critical region determined by the error rate α, for instance, p-value $<$ 0.05—not the particular magnitude of the p-value. NP's motivation was likely to reject the null and accept the alternative if the p-value $< \alpha$ or to accept the null and reject the alternative if the p-value $> \alpha$. However, aware of the limitations of their approach, NP observe that their framework "tells us nothing as to whether a particular case H is true ..." when the p-value $< \alpha$ (p. 291). The key words here are "particular case."

Consider flipping a coin. The null hypothesis is that the coin is fair. Given that it is fair, we know what the null distribution looks like. Suppose we run a trial and it produces 10 heads in 10 flips. Under the null, the probability of that happening is 0.00097 ($=0.5^{10}$). With a pre-established cutoff of 0.05, we reject the hypothesis that the coin is fair. Notice, however, that the magnitude of the p-value itself is not informative—the key is whether we are in the rejection region.

However, I have described only one experiment. The result could be different in a second experiment. The argument in NP is that if you follow a certain behavior or rule and reject if p-value < 0.05, then over the long run you will have a 5% error rate. To see what this means, consider an example that comes from product quality testing. A company uses a machine to manufacture a part and employs a separate instrument for quality control. The quality control instrument has a tolerance that can be physically established. With a cutoff or alpha of 5%, we know that over many trials 5% of the parts will be identified as defective when they are, in fact, not defective.[4] So on any given day, a part that has p-value < 0.05 is thrown out. It might be the case that, on this particular day every single rejection decision is wrong. However, if this rule is followed over the long run, the company will make the right decision 95% of the time. Another example comes from a legal setting (Goodman (1999)). On any given day all innocent defendants may be convicted, but if the decision rule is followed over the long run, on average innocent people will be convicted only 5% of the time. These examples illustrate what NP meant by "particular case."

As I mention above, NP suggest that the error rate α be set according to the particular situation. As α is decreased, the Type II error rate will usually increase. Consider, for example, a household water heater failing because it is defective versus a jet engine failing because it is defective. In the case of the jet engine, we are willing to accept a lot of false positives (incorrectly label a part defective) to minimize chances of false negatives (miss detecting a defective part), so α is set to a higher level. The particular situation therefore dictates not only how low α will be set but also the Type II error rate.

In sum, the NP approach is deductive and can best be thought of as a decision rule that is useful if the decision is made many times. We assume that we know the true error rate, and if our observations fall into a critical region, we

rate. However, in most situations, we would like the significance level to be exactly the same as the error rate. Another way to think about the difference is that the significance level is the *desired* level of Type I error whereas the error rate is the *actual* level of Type I error.

[4] I do not mention the power of the test, that is, the probability of correctly rejecting the null hypothesis, here because I am focusing on the false positive error rate.

reject the null. Importantly, this approach is not informative about a "particular case"—it is valid over the long run. In contrast, the Fisher approach is inductive. We examine the evidence, and this evidence leads to an increased probability of a conclusion. Again, Fisher thought of the p-value as only one input to be used in the decision-making process—but this input can change beliefs.

There was a fierce debate between Fisher and NP. Over time, Fisher's p-value has been embedded in the NP framework in a way that often obscures its original meaning. NP introduced the idea of the Type I error rate, which is the false positive rate in repetitive experiments. The p-value for a test statistic is compared to the Type I error threshold to determine the test outcome, creating a subtle link between the p-value and the Type I error rate. As a result, people often mistakenly describe the p-value as the Type I error rate.

Interestingly, both approaches have the same goal: to provide an alternative to Bayesian decision making, which many considered too subjective because a prior belief has to be imposed before a test is conducted. While the two approaches are incompatible, they are usually lumped together under the label of null hypothesis statistical testing (NHST). With years of confusion, the difference between p-values, error rates, and significance levels has become blurred. Indeed, the very definition of p-value is now subject to confusion. For example, many incorrectly believe that p-values give the probability that the result could have occurred by chance alone.

To illustrate the extent of the confusion, suppose you have an experimental hypothesis that U.S. public companies with small boards of directors outperform companies with large boards. You create two value-weighted portfolios and test for differences in mean returns (with a host of controls such as industry effects).[5] The key parameter of interest, the mean performance difference, is significant with $t = 2.7$ (p-value $= 0.01$). Consider the following six statements (true/false):

(i) You have disproved the null hypothesis (no difference in mean performance).
(ii) You have found the probability of the null hypothesis being true.
(iii) You have proved the hypothesis that firms with small boards outperform firms with large boards.
(iv) You can deduce the probability of your hypothesis (small better than large) being true.
(v) If you reject the null hypothesis (no difference), you know the probability that you are making a mistake.
(vi) You have a reliable finding in the sense that if, hypothetically, the experiment were repeated a large number of times, you would obtain a significant result 99% of the time.

All six of these statements are "false."[6] The main issues are as follows:

[5] For this illustration, I simplify the empirical tests. See Yermack (1996) and Coles, Daniel, and Naveen (2008).

[6] I adapt this example from Gigerenzer (2004).

(1) The p-value does not indicate whether the null hypothesis or the underlying experimental hypothesis is "true." It is also incorrect to interpret the test as providing $(1 - p\text{-value})\%$ confidence that the effect being tested is true. Hence, both (i) and (iii) are false.
(2) The p-value indicates the probability of observing an effect, D, (or greater) given the null hypothesis H_0 is true, that is, $p(D \mid H_0)$. It does not tell us $p(H_0 \mid D)$, and hence (ii) is false.
(3) The p-value says nothing about the experimental hypothesis being true or false, and hence (iv) is false. Question (v) also refers to the probability of a hypothesis that the p-value does not address, and hence (v) is false.
(4) The complement of the p-value does not tell us the probability that a similar effect will hold up in the future unless we know the null is true—and we do not. Hence, (vi) is false.

There are also a number of additional issues:

(5) The p-value is routinely used to choose among specifications, for example, specification A has a lower p-value than specification B and hence we choose specification A. However, comparing p-values across specifications has no statistical meaning. The p-value for one specification does not tell us that the other specification is true.
(6) A low p-value, while rejecting the null hypothesis, tells us little about the ability of the hypothesis to explain the data. For example, you might observe a low p-value but the model has a low R^2.
(7) Low p-values could result from failing to control for multiple testing.
(8) Low p-values could result from selection and/or p-hacking.
(9) Low p-values could result from a misspecified test.
(10) P-values crucially depend on the amount of data. It has been well-known since Berkson (1938, 1942) that, with enough data, you can reject almost any null hypothesis.
(11) P-values do not tell us about the size of the economic effect.[7]

Let me emphasize here the second point above: it is fundamentally important for researchers to answer the right question. A p-value tells us $p(D \mid H)$. However, it is often interpreted incorrectly as indicating $p(H \mid D)$. Carver (1978, pp. 384–385) colorfully illustrates how serious this mistake is as follows:

> What is the probability of obtaining a dead person (label this part D) given that the person was hanged (label this part H); this is, in symbol form, what is p(D | H)? Obviously, it will be very high, perhaps 0.97 or higher. Now, let us reverse the question. What is the probability that a person has been hanged (H), given that the person is dead (D); that is, what is p(H | D)? No one would be likely to make the mistake of substituting the first estimate (0.97) for the second (0.01); that is, to accept 0.97 as the

[7] A related issue is that an economically and statistically small change in a parameter may lead the parameter to change from "insignificant" to "significant." See Gelman and Stern (2006).

probability that a person has been hanged given that the person is dead. Even though this seems to be an unlikely mistake, it is exactly the kind of mistake that is made with interpretations of statistical significance testing—by analogy, calculated estimates of p(H | D) are interpreted as if they were estimates of p(D | H), when they are clearly not the same.

The confusion surrounding the use of p-values has led to considerable discussion among scientists (Nuzzo (2014)). Indeed, in an extraordinary move in 2015, a social psychology journal banned the publication of p-values in any of their papers (Trafimow and Marks (2015)). Other scientific fields such as epidemiology have also demonstrated an aversion to publishing p-values (Lang, Rothman, and Cann (1998)). Related concerns recently prompted an intervention by the American Statistical Association.[8]

A. The American Statistical Association's Six Principles

Concerned about the growing crisis in the conduct of scientific experiments,[9] and the declining public confidence in the integrity of scientific experiments, the Board of Directors of the American Statistical Association tasked Ronald Wasserstein to assemble senior experts in the field with the goal of developing a statement that would help correct the course. In March 2016, the Association released "Statement on Statistical Significance and *P*-Values" (American Statistical Association (2016)). The statement and associated paper (Wasserstein and Lazar (2016)) is a reaction to the perception that much of the scientific field misunderstands statistical significance, and that in many cases researchers are substituting p-values for scientific reasoning. The statement decries the fact that "the p-value has become a gatekeeper for whether work is publishable" and makes specific references to both p-hacking and data dredging (p. 1).

Below I reproduce the key principles outlined in the statement and comment on each one in the context of our field.

(1) *P-values can indicate how incompatible the data are with a specified statistical model*. The specified statistical model might be the null hypothesis of no effect. For example, consider the null hypothesis that expected stock returns are constant. The alternative is that past returns predict future returns. A low p-value tells us that the observed data appear to be incompatible with the null hypothesis.

(2) *P-values do not measure the probability that the studied hypothesis is true, or the probability that the data were produced by random chance alone*. Returning to the stock autocorrelation test, a low p-value is inconsistent with the hypothesis that expected returns are constant. A low p-value

[8] In a famous paper published in *PLoS Medicine*, Ioannidis (2005) argues that "most published research findings [in his and related fields] are false." It is the most read and shared article in *PLoS Medicine*'s history with 2.2 million views. Of course, as some argue, in medicine the stakes are higher than in financial economics: life or death.

[9] See also Gelman and Loken (2014).

does not imply that the autocorrelation model is "true." In addition, a high p-value does not mean that the hypothesis that expected returns are constant (i.e., stock returns are pure noise) is "true." Many other tests (e.g., introducing other information like dividend yields) may show that the data are not consistent with the null hypothesis.

(3) *Scientific conclusions and business or policy decisions should not be based only on whether a p-value passes a specific threshold*. It is rare that there is a clean dividing line between "true" and "false," and a p-value should not be used as such a dividing line. Rather, it is crucial to account for other factors such as the plausibility of the theory and its assumptions, the quality of the data, and any other evidence that might be relevant for the study. Indeed, this point is explicitly recognized by Fisher (1925), who notes that p-values do not substitute for "critical examinations of general scientific questions, which would require the examination of much more extended data, and of other evidence . . . ."

(4) *Proper inference requires full reporting and transparency*. Reporting select results that have low p-values makes it impossible to interpret the analysis. Such practice amounts to p-hacking and borders on academic fraud. Indeed, the American Finance Association's *Code of Professional Conduct and Ethics* states in Section 6d(4) that "Financial economists should not selectively report findings in ways that would mislead or deceive readers" (2016). For interpretation, it is essential that researchers reveal the full extent of all hypotheses tested. Internet appendices have made it easier to provide all test results.

(5) *A p-value, or statistical significance, does not measure the size of an effect or the importance of a result*. On the size of an effect, I believe that financial economists do a much better job than researchers in other fields. Articles in finance journals routinely report both economic and statistical significance. Economic significance is often described as the impact of moving from the first quartile to the third quartile of the distribution of the variable in question (it should not be the impact of moving from the 1^{st} to the 99^{th} percentile). The size of an effect is often ignored or misconstrued in other fields. For example, a study published in the prestigious *Proceedings of the National Academy of Science* (*PNAS*) that involved a large sample of over 19,000 married couples concluded that couples that met online were happier than those that met offline, with p-value < 0.0001, but a careful reading of the paper reveals that the size of the effect is tiny: the couples that met online scored 5.64/7.00 while those that met offline scored 5.48/7.00 (Cacioppo et al. (2013)).[10] And misconstruing the size of an effect is routine in medicine (Hutton

[10] However, it is crucial to know the variation in happiness across couples. Cacioppo et al. (2013, p. 10,136) report that $M = 5.64$, $SE = 0.02$, and $n = 5{,}349$ for one group while $M = 5.48$, $SE = 0.01$, $n = 12{,}253$ for the other group. If the mean is 5.64 and the standard error for the mean is 0.02, then the individual standard error is about $0.02 \times \sqrt{5{,}349} = 1.4$. So there is a lot of variation across individuals.

(2010)). For instance, as a result of a large-scale study on the impact of statin drugs on nonfatal coronary events, an advertisement proclaimed that these drugs "reduce the risk of heart attack by 36%."[11] Yet the incidence of heart attacks reported in the study (Sever et al. (2003, table 3)) was 2.7 per 100 among the placebo and 1.7 per 100 among the patients taking the statin. Thus, while the relative risk decreases by 36%, the absolute risk decreases by only 1%.

While the reporting of economic significance is fairly routine in finance journals, it is common to see the effect of variables with a low p-value described using the word "strong." It is possible, however, to observe a low p-value for an effect that explains only a modest part of the variation in the measure of interest.

(6) *By itself, a p-value does not provide a good measure of evidence regarding a model or hypothesis*. A low p-value offers only weak evidence against the null hypothesis, and such evidence is especially weak if you believe that the incidence of the effect in question is rare (see Section VI below). Similarly, a high p-value does not imply that the null hypothesis is true. It is therefore important not to stop the analysis once a p-value is obtained. Potentially, additional data can be gathered to bolster confidence in the conclusions.

III. *P*-hacking

As I mention in the introduction, editors' focus on publishing the most significant results can induce authors not to submit articles with weak results or to cherry-pick the results that they submit to a journal, that is, to engage in p-hacking. Focusing here on the latter, there are many forms of p-hacking, with some more egregious than others. For example, running thousands of correlations and reporting only the most significant one constitutes academic fraud. Such a practice is red flagged by the American Statistical Association (2016) and is contrary to the American Finance Association's *Code of Professional Conduct and Ethics*. A more subtle version of this type of p-hacking is studying correlations among, say, 11 variables and choosing to report only 10 of the correlations. Unfortunately, not reporting all variables examined in empirical work is commonplace in financial economics.

P-hacking is not limited to the reporting of individual explanatory variables. Often researchers investigate aggregation schemes. For example, suppose 11 variables are tried and none pass the usual test for "significance." Suppose further that various aggregations are tried and the sum of three of the 11 variables passes the usual hurdle for significance. Only reporting this particular aggregation amounts to p-hacking.

P-hacking also occurs when the researcher tries a number of statistical approaches (e.g., linear probability vs. Logit or Probit, panel regression vs. Fama-MacBeth (1973), Newey-West (1987) lag 1 vs. lag 4, different clustering

[11] A full-page ad appeared in the *Wall Street Journal*, November 6, 2007, p. A13.

choices, different choices of instrumental variables) and reports the one with the most impressive "significance." Indeed, self-serving reasoning often leads researchers to convince themselves that the most significant result is the one the researcher originally intended to examine.

Data manipulation and exclusion can also lead to p-hacking. Researchers make many choices in terms of standardization, log or other transformations, winsorization, and outlier exclusion. If these choices lead to the most significant results being presented, this is p-hacking. Similarly, the choice of data set can lead to p-hacking. For example, if the researcher reports a significant result using the 1970 to 2017 period and does not reveal that the same result is weaker in the 1960 to 2017 period, this is p-hacking. P-hacking is more difficult to detect with proprietary data where replication is costly. If a researcher intends to hand-collect data on say 1,000 companies, starts to conduct analysis midway through the data collection, and stops the data collection upon finding a significant result, this too is p-hacking (Simonsohn, Nelson, and Simmons (2014), Head et al. (2015)).

Indeed, researchers might not even know that their results reflect p-hacking. For example, delegating analysis to a research assistant may lead to p-hacking if the assistant searches for a result that they think the researcher will be "pleased" with.

To gauge the degree of publication bias, one can look at the distribution of p-values. Both selection (file drawer effect) and p-hacking induce patterns in the distribution of p-values. If there is no effect (e.g., there is no reason for Y to be correlated with X), the p-value distribution should be flat (e.g., a 10% probability of obtaining a p-value of 0.10 or less and a 2% probability of obtaining a p-value of 0.02 or less when the null hypothesis is true), as in the solid line in Panel A of Figure 4. For example, in my ticker symbol exercise, the distribution of p-values is flat. However, if there is an effect, the distribution is not flat (there are substantially higher probabilities of getting a p-value of 0.05 than a p-value of 0.10 or 0.20), as shown in the solid curve in Panel B of Figure 4.

The dashed lines in Figure 4 show the effect of selection. If papers are not submitted to journals with marginal p-values (say 0.05 to 0.10), then the distribution shifts downward to the right of 0.05 (dashed lines).

Using this same type of analysis, Figure 5 shows the impact of p-hacking. The figure plots the same initial p-curves as in Figure 4 using solid lines and the impact of p-hacking using dashed lines. The area of interest is below a p-value of 0.05. In both panels, there are more results than expected just below the 0.05 threshold. Thus, as can be seen, p-hacking has a much different effect from selection: while selection decreases the number of papers published, p-hacking increases the number of "significant" results that are published.

Using data from HLZ (2016), Figure 6 plots the distribution of p-values in factor studies. There is good news and bad news. The good news is that the curve is not flat, which is what you would expect to see if the null hypothesis of no factors were true. The bad news is that the selection effect is obvious, which is also evident in Figure 1, where a surprisingly small number of studies are

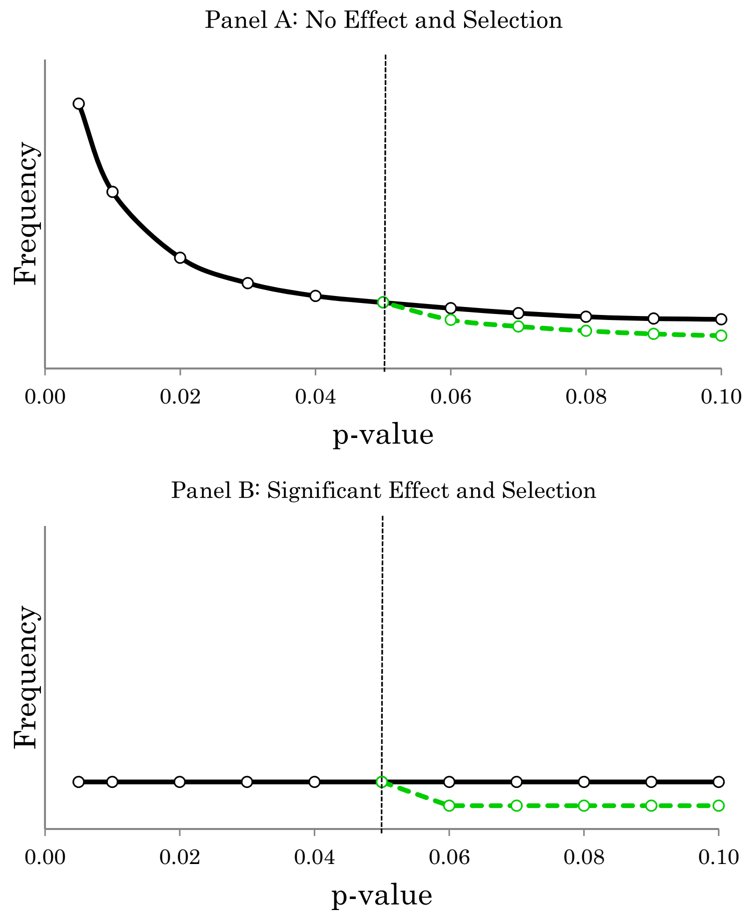

Figure 4. Impact of selection (file drawer effect) on *p*-values. Panels from Head et al. (2015). The solid lines represent the distribution of *p*-values. The dashed lines show the impact of selection.

published with $2.0 < t < 2.57$. In effect, the *p*-value threshold for publication in factor studies is not 0.05 but 0.01 for top finance journals.

IV. The Problem of Rare Incidence and Improbable Effects

A rare occurrence is an event that occurs very infrequently, such as the onset of a rare disease. An improbable occurrence is different; in this case, the effect is implausible. Both pose the same challenge to inference using traditional statistical tools. In most areas of finance research, the likelihood that empirical researchers uncover a true causal relation is small. When guided by theory, the probability could be higher, but not by much given the multiplicity of theories available for each area of research and the fact that some theories are constructed to fit known facts.

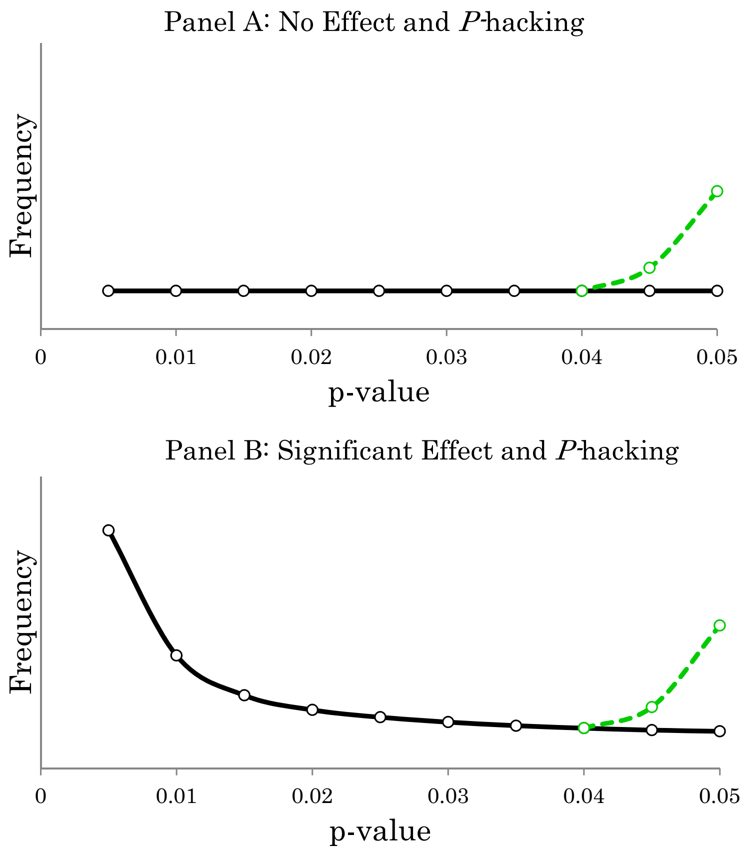

Figure 5. Impact of *p*-hacking on *p*-values. Panels from Head et al. (2015). The solid lines represent the distribution of *p*-values. The dashed lines show the impact of *p*-hacking.

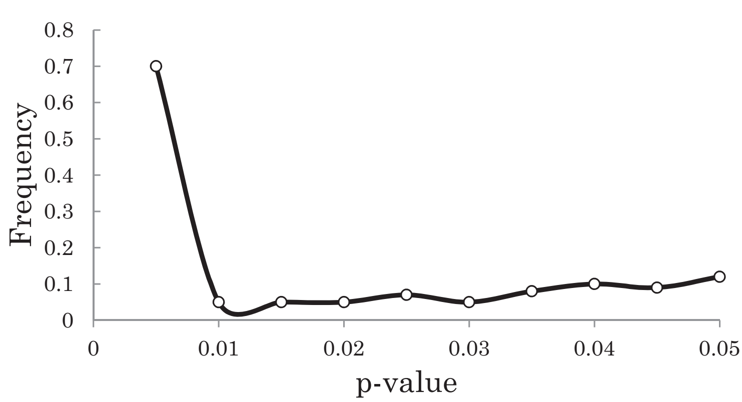

Figure 6. The distribution of *p*-values in factor studies. Data from Harvey, Liu, and Zhu (2016).

When a particular effect is unlikely, classical hypothesis testing often leads to severely biased testing outcomes. Unfortunately, such bias is generally not mentioned in empirical research. This may be changing after Bem's (2011) positive finding on extrasensory perception published in a top journal drew many top statisticians' critiques (e.g., Francis (2012), Ritchie, Wiseman, and French (2012)).

I illustrate the problem with a rare incidence example from medical science. For women between the age of 40 and 50, breast cancer is a relatively rare event that impacts only 1% of this age group. The first-line test, a mammogram, is 90% accurate in diagnosing cancer. This is the "power" of the test, that is, the probability of correctly rejecting the null hypothesis of no cancer. Let us assume that the rate of false diagnosis, or the error rate, is 10%. Suppose a woman is told that the test is positive. What is the probability that this woman has breast cancer?

Suppose that among 1,000 cases, 10 (=1,000 $\times$ 1%) have breast cancer and the remaining 990 do not. For those with breast cancer, the rate of successful diagnosis is 90%, so 9 of 10 will be correctly diagnosed as having breast cancer. For those without breast cancer, 10% or 99 (=990 $\times$ 10%) will be incorrectly identified as having breast cancer. The rate of incorrectly rejecting the null (or Type I error) is often referred to as the "error rate" of the test or the significance level.

In this example, the error rate is a combination of the accuracy of the mammogram machine and our tolerance for false negatives (missed diagnoses). Thus, if we raise the significance level from, say, $t > 1.6$ to $t > 2$ (say 5%), this might mean that more people with cancer are misdiagnosed as free of cancer, while if we set the threshold so low that all 10 women with cancer are correctly diagnosed, there will be a huge number of false positives.[12]

If the mammogram machine has been running a long time, we can learn about its performance at various test thresholds. It might be the case that, over the long run, setting the threshold at $t > 1.6$ produces a 10% false positive rate. However, in most applications we do not have this luxury—we are considering a new data set or running a new test on a well-known data set.

Turning back to the example, a total of 108 (=9 + 99) patients test positive for cancer and the rate of false positives is 92% (=99/(9 + 99)), even though individually the rate of false positives is only 10%. The high rate of false positives in breast cancer diagnoses is a well-known issue in medical research that has spurred the development of enhanced mammogram tests that reduce this rate by increasing the power of the test.

Consider another example. Nosek, Spies, and Motyl (2012) examine the hypothesis that political extremists see only black and white, literally. In an Internet-based experiment, they presented 1,979 participants with

[12] In general, there is no universal relation between a test's power and the error rate. In most situations, power increases as the error rate increases. Even in the simplest testing scenario, where we test for the mean difference, the exact relationship between the error rate and the test's power depends on the sample size.

noncontroversial words that appeared in different shades of gray. The participants were asked to identify the shades of gray from a color gradient. Determining the accuracy of the choice was straightforward because the color of each word had an exact match on the gradient.

Following the experiment, the participants were classified into two groups—political moderates and political extremists. Moderates saw shades of gray more accurately than left- or right-wing extremists, with a p-value of 0.001 providing strong evidence against the null hypothesis of no difference. Obviously, this is a striking finding that potentially links physiology to political beliefs.

Before submitting the paper for publication, however, the authors replicated the experiment using 1,300 additional participants. The replication p-value was vastly different, at 0.59. As Nuzzo (2014, p. 151) writes, the "more implausible the hypothesis—telepathy, aliens, homeopathy—the greater the chance that the exciting finding is a false alarm, no matter what the p-value is."

What insight does the above discussion have for research in financial economics? The key takeaway is that the more improbable the effect, the more careful we have to be because there will be many false positives. Let π be the probability of encountering a true causal relationship. In the context of hypothesis testing, α denotes the significance level when the null is true and β denotes the power of the test (the probability that the test will reject the null when the alternative is true). If tests are independent, the expected fraction of false discoveries is given by

$$\text{Expected fraction of false discoveries} = \frac{\alpha}{\frac{\pi}{1-\pi}\beta + \alpha},$$

where $\frac{\pi}{1-\pi}$ is the odds ratio of true versus false hypotheses.

We can use the above formula to calibrate the false discovery rate for research in financial economics. As we often do in empirical research, we fix the test threshold α at a prespecified level (e.g., 5%). Holding α constant, the minimum level of the expected fraction of false discoveries is $\frac{\alpha}{\frac{\pi}{1-\pi}+\alpha}$, which is achieved when the test's power (i.e., β) is 100%. However, if π is much smaller than α (i.e., the effect is rare), then this minimum level is approximately $1/(1 + \pi/\alpha)$, which is close to one. Hence, if a true discovery is unlikely, then no matter how powerful the test is, the probability of a false discovery is high. This aggregate view of false discoveries in finance research, which is distinct from the usual concern for single-hypothesis tests, casts doubt on the credibility of many empirical findings.

Table I reports false discovery rates for various degrees of unlikeliness for the effect in question and various significance levels for three levels of test power. Even when the test power is 100%, which means that all women with cancer are correctly diagnosed, the false positive rate is an alarming 83% at the 0.05 level of significance.

Among the many specifications in Table I, the significance level is nominal only when the odds of the null hypothesis being true are 1:1. How often do

Table I

The Rate of False Discovery Depends on Test Power and Error Rate

This table shows the probability that the null hypothesis is true for three levels of power.

	Prior Beliefs (Odds, Null:Alternative)					
	Long Shot 99-to-1 0.01	49-to-1 0.02	24-to-1 0.04	19-to-1 0.05	4-to-1 0.20	Even Odds 1-to-1 0.50
	Panel A: Power = 1.00					
Significance level (α)						
0.100	0.91	0.83	0.71	0.66	0.29	0.09
0.050	0.83	0.71	0.55	0.49	0.17	0.05
0.010	0.50	0.33	0.19	0.16	0.04	0.01
0.001	0.09	0.05	0.02	0.02	0.004	0.001
	Panel B: Power = 0.9					
Significance level (α)						
0.100	0.92	0.84	0.73	0.68	0.31	0.10
0.050	0.85	0.73	0.57	0.51	0.18	0.05
0.010	0.52	0.35	0.21	0.17	0.04	0.01
0.001	0.10	0.05	0.03	0.02	0.004	0.001
	Panel C: Power = 0.8					
Significance level (α)						
0.100	0.93	0.86	0.75	0.70	0.33	0.11
0.050	0.86	0.75	0.60	0.54	0.20	0.06
0.010	0.55	0.38	0.23	0.19	0.05	0.01
0.001	0.11	0.06	0.03	0.02	0.005	0.001

we see such odds in empirical research in our field? Take, for example, the literature on return predictability. Among the many variables that researchers have explored, how many do we believe have 1:1 odds of being true return predictors before we look at the data? Very few. However, we do not take these prior beliefs into account when calculating and interpreting p-values. It is therefore not surprising to see that most of the factors identified as return predictors are dismissed in out-of-sample tests as in Welch and Goyal (2008).

A more interesting exercise is to think about the time evolution of the rate of false discoveries for a particular strand of research. Take, for example, the discovery of anomalies. HLZ (2016) document an explosion of anomaly discovery over the last two decades. They argue that, under traditional single-hypothesis tests, the rate of false discoveries should also increase. The rationale is that the ex ante probability of running into a true anomaly should decline over time.

There are several reasons for a declining rate of anomaly discovery. First, true anomalies should become more scarce over time as the low-hanging fruit has been picked. Second, as we run out of theories based on first principles, we rely more on specialized theories, which inevitably imply a lower rate of true

discovery ex ante. Finally, relative to the large number of financial variables and firm characteristics that one can explore, the number of securities is limited.

The discussion so far bears a simple Bayesian interpretation. If the prior probability of a true discovery is low, then the posterior probability is also likely to be low across a wide range of choices for error rates and test power. Such posterior probabilities, when compared to the often-reported frequentist p-values that are based on the particular hypotheses being analyzed, should be more helpful for researchers to guard against false discoveries from a population perspective.

V. We Are All Bayesians

If you are rational, then you are a Bayesian. The most rudimentary example of the link to rationality is Bayes' Rule: we have some belief about an effect, we observe the data, and then we revise our belief. The key addition in the Bayesian statistical framework is incorporating prior beliefs. Indeed, if you accept the argument that the false positive rate should be higher for theories that are unlikely, then you have already adopted a fundamentally Bayesian line of reasoning.

Let me motivate the use of prior beliefs with an example from a famous letter written by Leonard Savage in 1962 (see Greenhouse (2012) and Churchill (2014)). Consider three experiments. In the first experiment, a musicologist claims to be able to distinguish between pages of music written by Mozart or Haydn. Using 10 pairs of score pages, Mozart versus Haydn, the musicologist identifies each one correctly. In the second experiment, an elderly woman claims that she can tell if milk was put in a tea cup before or after the hot tea was poured in. Again using 10 different trials, the woman identifies each one correctly. In the third experiment, a patron at a bar claims that alcohol helps him predict the future. You conduct an experiment using 10 coin flips and the patron correctly guesses heads or tails for each flip.

In each of these experiments, the p-value is less than 0.001 ($=1/2^{10}$), which is highly significant under the usual standards. However, what you take away from each test should be different. In the first test, you know that the test subject is a musicologist. This is her area of expertise and there is little reason for her to make a false claim. Indeed, it is not even obvious that you need to run the experiment to verify her claim, but in doing so the experiment confirms what you already believe. In the second case, maybe you are initially skeptical of the claim, but the evidence convinces you. Personally, I remember my grandfather sending his tea back at a restaurant because he always asked for the tea bag to be put in the pot before the water was added; he knew when the server got it wrong. So in the second experiment, there is a shift in your beliefs given the outcome of the experiment. What about the third experiment? The claim that alcohol causes clairvoyance is preposterous. Thus, while the p-value is less than 0.001, you chalk this up to luck—such an occurrence should happen naturally once in every 1,024 trials—and your beliefs are largely unaffected.

These simple examples illustrate two points. First, as I discuss earlier, if the effect is improbable (a drunk foretelling the future), there will be a lot of false positives using the standard NHST framework. Second, and more importantly, what really counts is the ability of the test to change beliefs. In the first and third tests, beliefs do not change as a result of the evidence. In the second test, beliefs are updated.

VI. The Bayesian Critique

Most empirical research in financial economics is conducted in the classical mode. There are many reasons for this. For instance, many researchers are uncomfortable specifying prior beliefs, as the imposition of a prior may be arbitrary in that it impacts the results. The perceived computational burden is also higher under a Bayesian approach, as are the econometrics—not just to the researcher but also to the readers of the research.

The longstanding debate on hypothesis testing between Bayesian and frequentist statisticians likely originated with Berkson's (1938) observation that you can reject almost any null hypothesis with enough data. My goal is to explore a few ideas that are easy to implement and that provide supplementary information to the usual test statistics. Before doing so, however, it is useful to review the objections that Bayesians have to NHST.[13]

(1) *Probability is a long-run concept for a frequentist*. The probability that comes out of the classical test assumes that we have many hypothetical samples and that the probability is the limiting frequency over these many samples. Using a Bayesian approach, no such assumption is necessary. The only data that are relevant are the data involved in the test.

(2) *There are issues with the structure of the hypothesis test*. The null hypothesis is often set to zero. For example, we test mutual fund manager performance against a null of zero excess returns. Why zero? Similarly, we compare the difference between two populations and start with the null that there is no difference—but they will never be exactly equal. Indeed, the null hypothesis is unlikely to ever be true (Cohen (1994)) and we are sure to reject the null hypothesis with enough data. In addition, under NHST, there is no direct inference on the alternative hypothesis. In my earlier example of autocorrelation in stock returns, NHST may reject the null hypothesis of no serial correlation but it cannot tell us whether the alternative hypothesis is true. Finally, what is so special about the significance level of 0.05? This is an arbitrary cutoff.

(3) *Prior information is ignored*. This point is emphasized in Savage's examples involving the musicologist, the tea drinker, and the bar patron. There is no way to formally incorporate prior information into the classical approach.

[13] This list comes in part from http://www.stats.org.uk/statistical-inference/, which also contains an extensive bibliography.

(4) *P-values are subject to manipulation*. Earlier I presented a p-hacking example where a researcher intending to hand-collect information on 1,000 companies stops upon finding "significant" results. Using the Bayesian approach may not necessarily cure this problem—a Bayesian might also stop data collection in the middle of the collection process—but a Bayesian might use one part of the data to inform additional analysis of another part of the data (Jarosz and Wiley (2014)). Of course, the Bayesian chooses the prior, which some might consider the ultimate "hack." However, the prior is transparent and skeptical readers can use whatever prior they think is appropriate.

(5) *P-values do not really answer the right question*. As I emphasized earlier, p-values do not tell us the probability of the null hypothesis being true given the data, $p(H_0 \mid D)$. Rather, they simply indicate the probability with which the particular evidence will arise if the null hypothesis is true, $p(D \mid H_0)$ (Carver (1978)).

VII. A Compromise

Let us begin with a not-so-modest proposal, namely, the full-blown Bayesian approach. Using this approach, we first take prior information into account by specifying a prior on all possible hypotheses—for each hypothesis, we calculate the data likelihood given the null. Then, using Bayes's theorem, we derive the posterior probability for each hypothesis. The full-blown Bayesian approach results in a probabilistic assessment of all hypotheses given the data and thus involves inductive reasoning.

The downside of this approach is that it requires a prior, which is often hard to come by. This raises the question of whether we can avoid using a prior and still enjoy the advantages of the Bayesian approach.

The original NP framework, which requires that the researcher specify both a null and an alternative hypothesis, partly achieves this. It shares several features of the full Bayesian model. For example, the NP test statistic—the likelihood ratio—weighs the likelihood of the data under the null against the likelihood under the alternative. This is similar to the Bayesian approach where the likelihood ratio is used to adjust the ratio of the prior likelihood under both the null and the alternative. But there are important differences between the NP and the full Bayesian approaches. In particular, the NP approach relies on the distribution of the test statistic under the null hypothesis to make inferences and does not provide a probabilistic assessment of the relative likelihood of the null and the alternative. As such, it inherently involves deductive reasoning.[14]

Unfortunately, we usually do not have well-specified alternatives in financial economics. As a result, use of the NP approach is limited. This begs the question

[14] Under the NP approach, if the null is true, we are unlikely to observe the data so we reject the premise that the null is true. This is deductive reasoning. Under the Bayesian approach, given the data, we assign probabilities to different premises. This is inductive reasoning.

of whether we can adapt the Bayesian approach to obtain a metric that does not depend on the specification of the alternative.

The minimum Bayes factor (MBF) under the null, as developed by Edwards, Lindman, and Savage (1963), is one such metric. Let us start with the definition of the Bayes factor under the null. Under Bayes's theorem, the posterior odds ratio between the null model and the model under alternative hypotheses equals the prior odds ratio—the odds ratio before we see the data—times the Bayes factor, which is the ratio of the data likelihood under the null and the data likelihood under alternative hypotheses.[15] In other words, the Bayes factor measures how far we move away from the prior odds ratio after seeing the data.

In general, the Bayes factor still depends on the prior specification of the alternative hypotheses. But a special version of the Bayes factor, the MBF, does not. The MBF is the lower bound among all Bayes factors. It occurs when the density of the prior distribution of alternative hypotheses concentrates at the maximum likelihood estimate of the data. In other words, if prior information makes you focus on one particular alternative hypothesis that turns out to be the value that is most supported by the data, then you have the MBF. Because the MBF indicates the maximum amount the data can move you away from your priors in terms of the odds ratio, it is the Bayes factor that provides the strongest evidence against the null hypothesis.

Consider the following example. Suppose you have 1,000 observations of returns. Your null hypothesis is that the average return is zero. The average return in the data is 0.04. Your prior odds ratio is 3/7, that is, you believe that the null is true with 30% probability. Which prior specification of the alternatives will deliver the strongest evidence against the null hypothesis? It is obvious that setting all of the 70% prior mass at 0.04 achieves this.

Consider another example. Suppose the MBF is 1/10. This implies that the data suggest that we should multiply our prior odds ratio by a factor of at least 1/10. If the prior odds ratio is 1/1 (50% probability, that is, even odds), then the posterior odds ratio becomes 1/10, which corresponds to a probability of 9% (= 1/(10 + 1)) for the null hypothesis. To achieve a posterior probability of 5%

[15] In particular, we have $\frac{f(\theta_0|data)}{f(alternative|data)} = \frac{f(data|\theta_0)}{\int f(data|\theta)\pi_A(\theta)d\theta} \times \frac{\pi_0}{\pi_1}$, where $\pi_A(\theta)$ is the probability density under the alternative hypothesis, $f(x|y)$ is probability density function of x conditional on y, and π_0 and π_1 are the prior probabilities for the null and alternative hypotheses. Note, for frequentists, $f(data|\theta_0)$ is usually called the probability density function and $f(\theta_0|data)$ is called the likelihood function. But for Bayesians, data and parameters are both random, so we use likelihood and probability for both $f(data|\theta_0)$ and $f(\theta_0|data)$. The posterior odds ratio is $\frac{f(\theta_0|data)}{f(alternative|data)}$, the prior odds ratio is $\frac{\pi_0}{\pi_1}$, and the Bayes factor is $\frac{f(data|\theta_0)}{\int f(data|\theta)\pi_A(\theta)d\theta}$. Notice that, while the null hypothesis is necessarily a single number, we can have a continuous density on alternative hypotheses. In this case, the data likelihood under alternative hypotheses is given by $\int f(data|\theta)\pi_A(\theta)d\theta$, where $\pi_A(\theta)$ is the probability density under the alternative hypothesis. In the special case in which the alternative hypothesis is a single number, $\pi_A(\theta)$ reduces to a point mass at θ_A and the data likelihood under the alternative hypotheses becomes $f(data|\theta_A)$.

for the null hypothesis (posterior odds ratio = 5/95), the evidence needs to be stronger (i.e., the MBF needs to be smaller).[16]

What makes the MBF even more useful is that it is easy to calculate in many situations. If a test is based on a normal approximation and the z-score is given by Z, then the MBF is simply $\exp(-Z^2/2)$ where $\exp(\cdot)$ denotes the natural exponent. Hence, a z-score of 2.0, which has a p-value of 5%, corresponds to an MBF of 0.14.

Consider yet another example. Suppose our null hypothesis is that the variable Y is not predictable. We regress Y on X with 300 observations and find a "significant" coefficient with a t-statistic of 2.6, which has a p-value of 0.014. The MBF derived from this alternative (i.e., the estimated value of the coefficient) is 0.034 ($\exp[-2.6^2/2]$). Suppose further that we think there are even odds that the null is true relative to the alternative. This means that there is a 0.033 chance the null is true (MBF $\times$ prior odds $= 0.034 \times 1.0 = 0.034$, probability of null $= 0.034/[1 + 0.034] = 0.033$). However, if you think there are modest odds against the effect, say 2:1, the probability that the null is true increases to 0.064. Essentially, we are creating "Bayesianized" p-values that tell us whether things are true instead of just rejection probabilities conditional on the null.

The MBF is most useful when we do not have any information about the specification of alternative hypotheses, as it is a "global" MBF across all prior specifications of alternative hypotheses. Of course, sometimes we do have information or priors on plausible alternatives. We can modify the MBF to incorporate such information. One useful adaptation calculates the MBF when we believe that the prior probability density for alternatives should be symmetric and descending around the null hypothesis. Let us call this MBF the SD-MBF, where SD denotes symmetric and descending. This type of MBF is relevant for many applications in finance, for instance, in cases in which we do not have a strong prior belief about whether a signal positively or negatively predicts returns.[17] The SD-MBF is given by $-\exp(1) \times p$-value $\times \ln(p$-value), is the natural exponent. The p-value is calculated under the null.[18]

What is the connection between the MBF and the SD-MBF? The MBF is the minimum across all possible prior specifications of alternative hypotheses, whereas the SD-MBF is the minimum across a specific class of prior specifications for the alternative hypothesis. Hence, the MBF is always smaller and presents stronger evidence against the null than the SD-MBF. This is intuitive as the MBF occurs when the entire prior probability mass on the alternative

[16] Alternatively, if the prior is tilted more toward the alternative (10/19 = (5/95)/(1/10)), a 5% posterior probability can be obtained.

[17] Other types of MBF are derived under alternative assumptions on the prior density for alternatives. See Berger and Sellke (1987) for examples of alternative types of MBF. In general, the prior density for alternatives that achieve a certain type of MBF depends on the data likelihood function under the null hypothesis. It does not need to have the form of well-known probability distributions.

[18] The SD-MBF is first proposed in Bayarii and Berger (1998, p. 81), who refer to this approach as "quick and dirty." Also see Goodman (2001) and Nuzzo (2014).

Table II

Using Minimum Bayes Factors to Calculate the Likelihood of the Null Hypothesis Being True (Bayesianized *P*-values)

This table reports the probability that the null is true. MBF is the minimum Bayes factor, $\exp(-Z^2/2)$; SD-MBF is the symmetric-descending minimum Bayes factor, $-\exp(1) \times p\text{-value} \times \ln(p\text{-value})$.

			Prior Beliefs (Odds, Null:Alternative)					
			Long Shot					Even Odds
	Usual		99-to-1	49-to-1	24-to-1	19-to-1	4-to-1	1-to-1
z-Score	*P*-value	MBF	0.01	0.02	0.04	0.05	0.20	0.50
			Panel A: MBF					
1.645	0.10	0.259	0.96	0.93	0.86	0.83	0.51	0.21
1.960	0.05	0.147	0.94	0.88	0.78	0.74	0.37	0.13
2.576	0.01	0.036	0.78	0.64	0.47	0.41	0.13	0.03
3.291	0.001	0.004	0.31	0.18	0.10	0.08	0.02	0.004
			Panel B: SD-MBF					
1.645	0.10	0.626	0.98	0.97	0.94	0.92	0.71	0.38
1.960	0.05	0.407	0.98	0.95	0.91	0.89	0.62	0.29
2.576	0.01	0.125	0.93	0.86	0.75	0.70	0.33	0.11
3.291	0.001	0.019	0.65	0.48	0.31	0.26	0.07	0.02

hypotheses concentrates on the maximum likelihood estimate of the data—so what we believe coincides with what we observe (via the maximum likelihood estimate), which implies the strongest evidence against the null. In contrast, if we do not have a good sense of what the alternatives should be, it may make sense to spread the prior probability mass on the alternative hypotheses across a wide range of values. Additionally, if we further restrict the prior density to be symmetric and descending around the null, then the SD-MBF, which is more lenient than the MBF (i.e., the MBF is more likely to reject the null), will be more informative when adjusting the prior odds ratio.

To summarize, we have a simple formula to transform the frequentist p-value and the prior probability of the null into a Bayesianized p-value:

$$\text{Bayesianized } p\text{-value} = \text{MBF} \times \frac{\text{prior odds}}{1 + \text{MBF} \times \text{prior odds}}.$$

This formula can be used for the MBF or the SD-MBF. Panel A of Table II presents several examples using four common p-values—0.001, 0.01, 0.05, and 0.10—for the MBF. Suppose you are testing an effect that you think is only about 20% likely to be true (prior odds are 4:1; notice odds $= p_0/(1 - p_0)$, where p_0 is the prior probability). Consider the frequentist p-value of 0.05, which would be significant under NHST assuming a 5% threshold. The MBF is 0.147. The formula above suggests that the Bayesianized p-value is 0.37 ($= (0.147 \times 4)/(1 + 0.147 \times 4)$). This means there is a 37% chance that the null hypothesis

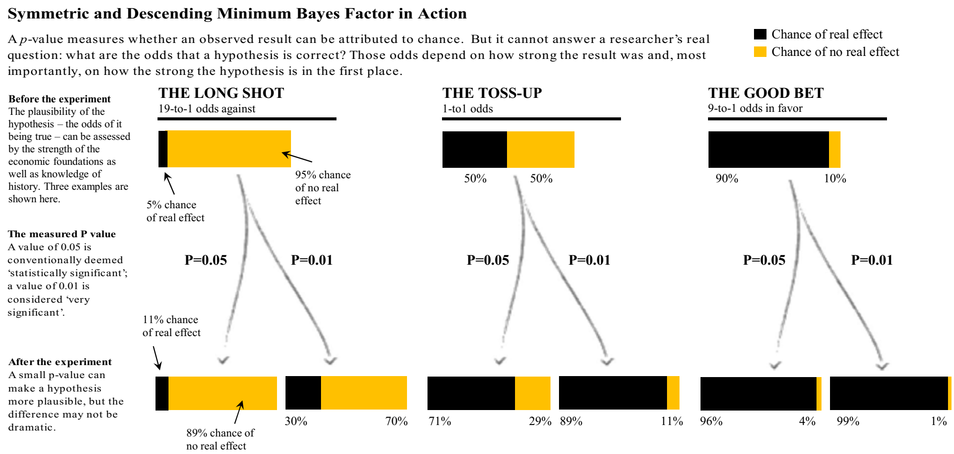

Figure 7. The SD-MBF Illustrated. Figure from Nuzzo (2014).

is true. If you instead think the prior odds are even (1:1), meaning you believe that there is a 50% chance that the effect is true, the Bayesianized p-value drops to 0.13. Notice that both of these values are higher than the usual p-value. I again emphasize the difference in interpretation. We can make *direct* statements about the viability of the null hypothesis under this framework. We cannot do so under the NHST framework because the classical p-value does not tell us the probability that the null hypothesis is true.

Panel B of Table II presents similar results for the SD-MBF. Continuing the example above, the Bayesianized p-value is 0.62 in the 4:1 odds case and 0.29 in the 1:1 odds case. The higher p-values are intuitive. The MBF gives the best possible shot to the alternative by concentrating the prior mass at the alternative while the SD-MBF concentrates the prior mass around the null hypothesis. Hence, the SD-MBF and its Bayesianized p-values are larger. So with even odds, there is a 29% chance the null is true. Again, the inference is much different than under the usual NHST.

The MBF p-value thus gives the smallest Bayesianized p-value among all possible priors that satisfy a given prior odds ratio. It is aggressive in the sense that it presents the strongest evidence against the null. A large MBF p-value implies a total lack of evidence to reject the null. A small MBF p-value implies possible rejection of the null and suggests that the researcher conduct further analysis. The SD-MBF is less aggressive than the MBF and is best used when we have a dispersed belief on plausible values under alternative hypotheses.

Figure 7 illustrates the SD-MBF in action. Notice that the evidence has the greatest impact on the probability of an effect when the prior odds are a toss-up. The values for the Long Shot and the Toss-Up cases can be found in Table II.

There is an additional way to illustrate the use of the MBF. One can set the level of confidence for the effect to be true, combine this with prior odds,

Table III

t-Statistic Thresholds for Minimum Bayes Factors

This table reports the threshold for the t-statistic corresponding to the probability that the null is true. MBF is the minimum Bayes factor, $\exp(-Z^2/2)$; SD-MBF is the symnmetric-descending minimum Bayes factor, $-\exp(1) \times p\text{-value} \times \ln(p\text{-value})$. In Panel A, we solve for the statistic S, $S = \sqrt{(-2 \times \ln(BPV/((1 - BPV) \times PO))}$, where BPV is the Bayesianized p-value in column 1 and PO is the prior odds (e.g., 4:1 = 4). In Panel B, we first solve numerically for the p-value, $0 = p\text{-value} \times \ln(p\text{-value}) - (-\exp(-1) \times BPV/((1 - BPV) \times PO))$, and then find the test statistic, S, corresponding to p-value/2.

	Prior Beliefs (Odds, Null:Alternative)					
Prob. Null is True	Long Shot 99-to-1 0.01	49-to-1 0.02	24-to-1 0.04	19-to-1 0.05	4-to-1 0.20	Even Odds 1-to-1 0.50
			Panel A: MBF			
0.10	3.69	3.49	3.28	3.21	2.68	2.10
0.05	3.88	3.70	3.50	3.43	2.94	2.43
0.01	4.29	4.12	3.94	3.88	3.46	3.03
0.001	4.80	4.65	4.49	4.44	4.07	3.72
			Panel B: SD-MBF			
0.10	4.10	3.92	3.72	3.65	3.16	2.63
0.05	4.29	4.11	3.93	3.86	3.41	2.93
0.01	4.67	4.51	4.35	4.29	3.89	3.49
0.001	5.16	5.02	4.87	4.82	4.47	4.13

and calculate the test statistic threshold necessary to match that confidence. I present such an example in Table III. Panel A reports the results for the MBF. Suppose you think a variable X has a 50-50 chance of being the true explanator of variable Y. In addition, you want the level of confidence to be such that there is only a 5% probability that the null is true. The t-statistic threshold is 2.43. This threshold is a higher hurdle than the usual t-statistic of 2.0. However, again, we are answering a different question here. As the variable becomes less likely in terms of prior odds, the threshold increases. For example, if you think the odds are 4:1 against X being the true explanatory variable, the threshold increases to 2.94. Panel B reports the equivalent thresholds for the SD-MBF. These thresholds are higher, which makes sense given that the MBF gives the alternative a better chance than the SD-MBF. For example, with even odds and a 5% probability that the null is true, the SD-MBF threshold is 2.93, which is higher than the 2.43 in Panel A.

Let us now return to the regression prediction example with a slope that has a t-statistic of 2.6 and a p-value of 0.014. The SD-MBF is 0.162. If the odds are even in terms of the null versus alternative, then the probability that the null is true is only 0.14.[19] Alternatively, if we want to enforce a 5% probability that

[19] SD-MBF $= -\exp(1) \times p\text{-value} \times \ln(p\text{-value}) = 0.162$; probability of null with even odds $= 0.162/(0.162 + 1) = 0.14$.

the null is true, we need $t > 2.93$ according to Table III. What assumptions are necessary here? To interpret the SD-MBF for the regression example, we first need to assume that the prior density on alternative values for the slope is symmetric and descending around zero. Under these assumptions, the SD-MBF is the minimum Bayes factor. In other words, in this regression setup, if you believe as a prior that the null (slope = 0) is more likely than other values and that a negative slope has the same likelihood as a positive slope with the same magnitude, then the SD-MBF is the minimum Bayes factor among all Bayes factors that can obtain under different prior probability densities for alternatives.[20]

Let us next apply the MBF and SD-MBF to the music, tea, and bar patron examples. All three experiments result in a traditional p-value close to 0.001. In the case of the music test, you already know that the test subject is a musicologist, so a 50% probability (1:1 odds) of the individual not being a musicologist (the null hypothesis) should be an overstatement of your prior. Even under this prior, you have strong evidence (the probability of the null being true is only 0.004 and 0.02 for the MBF and the SD-MBF, respectively) and you can confirm she is an expert. At the other extreme, in the case of the bar patron who claims to predict the future, a 99% probability (99:1 odds) of the patron making a false claim (the null hypothesis) should be an understatement of your prior. It is therefore not surprising to see that, even after 10 successful guesses in a row, the evidence for the alternative is still weak—the probability of the null being true (no clairvoyance) ranges from 0.33 to 0.66.

At the risk of being redundant, notice that our language has changed. Under the classical framework, the p-value is the probability of observing the outcome or a more extreme outcome if the null hypothesis is true. Under the MBF framework, we are able to talk about the probability that the null is true. We are also able to talk about the probability that the alternative is true.

In many cases, the MBF is a nonlinear transformation of the p-value. So does it simply report the p-value on a different scale? In a sense yes because no information besides the p-value is needed to calculate the MBF. However, it is not merely a transformation because it allows us to go from deductive reasoning as under the NP framework to inductive reasoning as under the full Bayesian approach. We are now able to make statements about the odds of the null hypothesis relative to alternative hypotheses. One key element of such statements—the MBF—is independent of the prior specification and

[20] My analysis assumes two-sided tests. This is the assumption under the Fisher framework when we do not specify the alternatives. When we deviate from this assumption, that is, when we employ one-sided tests, we are deviating from the Fisher framework by essentially incorporating prior information (although vague) on alternatives. This changes the calculation of p-values from two-sided to one-sided. This also changes the MBF and the SD-MBF as follows: if the data maximum likelihood estimate is inconsistent with your prior on the alternative (e.g., the null is $\mu = 0$ and you are testing $\mu = 0$ versus $\mu > 0$, in which case a negative data maximum likelihood estimate would be inconsistent with your prior on the alternative), then both the MBF and the SD-MBF should be exactly one, that is, the data do not provide any information to help distinguish the null from the alternative. Otherwise, the MBF and the SD-MBF are the same as in the two-sided case.

hence should carry the same meaning to all researchers. Thus, the MBF can be thought of as the bridge between the p-value, which is not related to the probabilities of different hypotheses, and something that is related to these probabilities.

Some may counter that the MBF is too subjective, since one still needs to specify a prior to calculate the posterior probabilities. However, as emphasized by Fisher (1925), there is no "objective" evaluation of hypotheses. Researchers in financial economics seem to ignore this fact and draw on p-values to make probabilistic assessments of different hypotheses. This leads to misleading interpretations of results and may confound the development of research. My goal here in suggesting that we include MBFs among our test statistics is to encourage researchers to first admit the necessity of subjective probabilities, to next specify a prior or set of priors, and to ultimately answer the question that we are really interested in: what is the probability that the null is true?

So far most of the applications of the MBF above have been illustrative in nature. I now turn to some real examples.

Let us first revisit the cancer example. For breast cancer diagnosis, the application is greatly simplified as there is one possible outcome under the alternative hypothesis, namely, the patient has breast cancer. As a result, we do not need to search among a large number of specifications for alternatives as in a typical MBF calculation. In this case, the MBF collapses to the usual Bayes factor, which equals the ratio between the probability of making a false diagnosis and the probability of making a correct diagnosis, or the error rate (α) divided by test power (β). Given a prior odds ratio, we can use the Bayes factor to derive the posterior likelihoods of both the null and the alternative hypothesis.[21] It is therefore straightforward to apply the MBF method to the breast cancer example, where there is only one possible value for the alternative hypothesis.

Notice how test power enters the Bayes factor and, as a special case of the Bayes factor, the MBF. Bayesian methods for hypothesis testing allow one to weigh the likelihood of the data under the null against the likelihood under the alternative and in doing so take test power into account. This is in contrast to the frequentist approach, where test power plays a less prominent role than the p-value and hence results in confusion when a large-sample result is presented as significant even when economically trivial.

Let us next consider the application of the MBF and the SD-MBF to four published studies. In Table IV, I divide the studies' findings into three categories based on prior beliefs: (1) "A stretch," meaning that the prior probability of the effect being true is 2%, (2) "Perhaps," meaning that the prior probability is in the 20% range, and (3) "Solid footing," meaning that the prior probability has even odds, that is, is 50%.

[21] Let π be the prior likelihood of the alternative. The prior odds ratio is $(1-\pi)/\pi$. Multiplying the prior odds ratio by the Bayes factor α/β, the posterior odds ratio is $\frac{1-\pi}{\pi}\frac{\alpha}{\beta}$, which implies a probability of $\frac{\frac{1-\pi}{\pi}\frac{\alpha}{\beta}}{\frac{1-\pi}{\pi}\frac{\alpha}{\beta}+1} = \frac{\alpha}{\frac{\pi}{1-\pi}\beta+\alpha}$ for the null. This is exactly the formula for the expected fraction of false discoveries that I presented earlier.

Table IV

Converting Published Classical *P*-values into Bayesianized *P*-values

This table reexamines the t-statistics and p-value presented in four academic papers. The table reports both MBF and SD-MBFs based on the reported p-values, where MBF = $\exp(-Z^2/2)$ and SD-MBF = $-\exp(1) \times p\text{-value} \times \ln(p\text{-value})$; prior odds ratios; as well as Bayesianized p-values that tell the probability that the null (factor not priced) is true, given the data.

Prior Category	Effect	Sample	Reported t-stat	Reported P-values	MBF	SD-MBF	Prior Odds Ratio (Null/Alternative)	Bayesianized P-values (MBF)	Bayesianized P-values (SD-MBF)
A stretch	Clever tickers outperform (Head, Smith, and Watson (2009))	1984 to 2005	2.66	0.0079	0.0291	0.1040	49/1	0.588	0.836
Perhaps	Profitability priced (Fama and French (2015))	1963 to 2013	2.92	0.0035	0.0141	0.0538	4/1	0.053	0.117
	Size priced (Fama and French (1992))	1963 to 1990	2.58	0.0099	0.0359	0.1242	4/1	0.125	0.332
Solid footing	Market beta priced (Fama and MacBeth (1973))	1935 to 1968	2.57	0.0100	0.0368	0.1252	1/1	0.035	0.111

The first study in Table IV—the ticker symbol study that I mention in the introduction of this paper—belongs to the "A stretch" category. Most of us would believe that stocks with clever ticker symbols are unlikely to outperform. Hence, the reported p-value in the original study, 0.0079, gives us little information about the likelihood of the effect. Calculating the two MBFs and combining them with the prior belief that the effect is a long shot, the probability that the null (i.e., no effect) is true ranges from 58.8% to 83.6%. The takeaway here is completely different from the standard inference.

Turning to a few findings in the "Perhaps" category, recent work suggests that firm profitability is priced in the cross-section of expected returns. The reported p-value is very low, at 0.0035. However, applying prior information potentially changes the inference. With a 20% prior probability that the effect is true, the SD-MBF suggests that there is a 11.7% probability that the null (i.e., no effect) is true. Similarly, with respect to the size factor, with a 20% prior probability that the effect is true, the SD-MBF suggests that there is a 33.2% probability that the null is true.

Finally, consider results on market beta, which belong to the "Solid footing" category. The reported p-value is 0.01. Under even odds (50% probability that the effect is true), the SD-MBF suggests that there is only an 11.1% probability that the null is true.

There is a simple message here: we cannot simply report the usual p-values. Given the rare effects problem, we somehow need to take prior beliefs into account. Tables III and IV demonstrate how easy it is to employ a Bayesianized approach without having to resort to the computationally challenging full-Bayesian framework.

VIII. Extensions and Limitations

The MBF approach detailed above crucially depends on the frequentist p-value and therefore suffers from many of the same issues that plague the p-value itself. One such issue is that a p-value usually does not tell us how well a model explains the data. For example, an investment factor that has a large t-statistic under cross-sectional tests may not help explain the cross-section of expected returns, that is, there may be a discrepancy between statistical significance and model adequacy. Given the discussion above, this discrepancy is not hard to understand. A classical p-value measures the degree of incompatibility between observed data and the null hypothesis, but cannot tell us what would happen under alternative hypotheses. It is possible that both the null and the alternative hypothesis have poor explanatory power vis-a-vis the data.

In contrast, a full-blown Bayesian approach depends less on the frequentist p-value as it explicitly compares the evidence (i.e., likelihood) under the alternative hypotheses with the evidence under the null hypothesis. Even if we have a small frequentist p-value, which implies a large discrepancy between the model and the data under the null hypothesis, we may still fail to "reject the null" under a full-blown Bayesian approach as this discrepancy could be

equally large under alternative hypotheses. In other words, compared to the full-blown Bayesian approach, we may "reject the null" too often under the MBF. This is consistent with the notion that the MBF might be too aggressive, where "aggressive" implies more rejections of the null. However, while the MBF might be too aggressive, it still evaluates the data under alternative hypotheses. Moreover, the usual p-value under NHST is far more aggressive and leads to unacceptable rates of false discoveries.

Compared to the MBF, the SD-MBF is less aggressive in that the maximum likelihood for the alternative hypotheses (i.e., the denominator in the Bayes factor) is calculated under a more constrained distributional family for the prior probability density of the alternative hypotheses, which generates a smaller likelihood under alternatives and hence a larger Bayes factor. As a result, it presents weaker evidence against the null compared to the MBF. In addition, the features of the prior density on the alternative hypotheses that the SD-MBF assumes appear to be appropriate for many hypothesis testing scenarios. We therefore expect SD-MBF to be more useful in empirical applications. Note that if we have more information about the prior probability density of the alternative hypotheses, we can incorporate this information into the calculation of the Bayes factor to derive alternative MBFs that are even more informative than the MBF and SD-MBF.[22]

There are limitations to using MBFs. Suppose we require a level of confidence such that the probability of the null being true must be 5% or less. We conduct an experiment and with even odds we find a Bayesianized p-value of 0.09. Here we fail to "reject the null" hypothesis of no effect because there is a 9% chance that the null is true. However, what happens if the Bayesianized p-value is 0.02 using the MBF? We already know that the MBF gives the alternative the best possible chance. Suppose that the SD-MBF in this case is 0.045. Are we done? That is, can we now confidently "reject the null?" Again, the results are not definitive as there is a lot of simplification going on. This ambiguity is the price that we have to pay for not explicitly specifying the alternative.

Based on the above discussion, I argue that the MBF and SD-MBF be used in an initial step to screen out those effects that are highly unlikely to be true.[23] Assuming that a hypothesized effect passes this first hurdle with a very small Bayesianized p-value, one might next go on to explicitly specify an alternative. I do not expect many researchers will do this due to the challenges of adopting the full Bayesian framework. Fortunately, Bayarri et al. (2016) show that over a wide number of experiments, the SD-MBF is very close to the full Bayes factor when p-values are low.

[22] See Berger and Sellke (1987) and Bayarri et al. (2016).

[23] This is not a trivial step. Many results in financial economics are not able to pass the hurdle using the MBF or SD-MBF once prior odds are taken into account, even if we give the alternative the best possible chance by using MBFs.

IX. Recommendations

This address is not meant to criticize the quality of the research that we have done in the past. But I believe it is essential for the future scientific outlook of financial economics that we embrace some of the guidelines developed in other fields.

Below I offer specific recommendations. These recommendations fall into two categories. The first focuses on how we conduct our research. The second focuses on the incentives in the publication process that impact the research culture in our field.

A. Research Methods[24]

Building on the various points made in this address, below I list recommendations for future work in financial economics.

- *Before looking at the data,* establish a research framework that includes: economic foundation, hypotheses to be tested, data collection methods (e.g., sample period, data exclusions, manipulations, and filters), tests to be executed, statistical methods, plan for reporting results, and robustness checks. The research framework should be transparent to all researchers. There is a growing trend in other sciences to post all these choices online before the experiment is conducted or the data are collected. See Open Science Foundation http://osf.io.
- Employ checklists. Consolidated Standards of Reporting Trials (CONSORT 2010) provides a detailed checklist for researchers in medicine doing clinical trials. Each of the top journals in this field has endorsed these guidelines.
- Recognize that any investigation is unlikely to yield a zero-one (false-true) outcome. Employ statistical tools that take this fact into account.
- Employ statistical methods that control for known research problems like multiple testing and inflation of effect sizes.
- Focus on both the magnitude and the sign of an effect, not just on the level of significance.
- Share nonproprietary data and code in an easily accessible way.
- Report all results, not just a selection of significant results. Internet Appendices make this easy to do.
- If the results relate to one topic, do not carve them up across separate papers—put everything into one paper if feasible.
- If a result is surprising, try to replicate the result perhaps on a new data set before submitting for publication.
- Strengthen evidence by conducting additional tests of the main hypothesis, provided these additional tests are not highly correlated with the initial test.

[24] Some of these recommendations come from Ioannidis (2008).

- Take priors into account. An effect that results from a theoretical prediction should be treated differently from an effect that arises from data mining, that is, economic plausibility must be part of the inference. Of course, care should be taken to avoid theory-hacking, where various assumptions are tried to fit the model to a known empirical phenomenon. Theories are more convincing if they have a new testable implication (in addition to explaining known patterns in the data). This is analogous to an out-of-sample test in empirical work.
- Alongside the usual test statistics, present Bayesianized p-values. You might report these measures, which give the probability that the null is true, with more than one prior so readers can make their own assessment as to the plausibility of the hypothesis given the test results.

B. The Agency Problem

Many of the problems that I describe above are endogenous in that agents are simply responding to incentives. At most schools, a single publication in a top journal like the *Journal of Finance* can lead to tenure. Even at many top schools, administrators track the number of publications and rewards are often tied to productivity. Researchers know that journals tend to publish papers with positive results. Editors know that papers with positive results get more citations. Many editors focus on the impact factor of their journal as a measure of success.

As I mention in the introduction, the above factors lead to a complex agency problem. Our goal is to advance scientific knowledge in our field. In doing so, we should care about discoveries—both positive and negative—that are repeatable, that is, discoveries for which the initial findings can be validated both in replication and in out-of-sample tests. In addition, we should not shy away from risky projects that could lead to a substantial leap in knowledge. However, the incentives of editors, peer reviewers,[25] and authors are not necessarily compatible with this goal.

While the main focus of HLZ (2016) is empirical methods, I fear that an unintended consequence of the paper's message is increased data mining in an effort to meet higher thresholds for significance. Adaptation of the Bayesian approach should mitigate this problem because many purely data-mined results suffer from a lack of economic foundation. As such, they are not likely to pass the hurdle if prior beliefs are incorporated.

I believe that another consequence of the path that we have been on in our field is a proliferation of papers that are technically well executed but that advance our knowledge only marginally. Suppose a researcher is choosing between two projects. One involves hand-collecting data over the course of a year while the other involves a standard data source like Compustat. The researcher has even odds on the main hypothesis in both projects.

[25] The peer review process is also part of the problem. See the discussion in Berk, Harvey, and Hirshleifer (2017).

The researcher also knows that it will be difficult to publish either of these papers if the result is negative. As a result, and this is especially true for younger researchers, the less risky project (i.e., the one not requiring time-consuming data collection) is often selected. However, it might be the case that the riskier project is the one that would most advance our knowledge.

I do not have a solution for this agency problem. It impacts not just our field but rather all scientific fields (though some more than others). However, I do have some ideas of steps we might take to mitigate the problem.

To start, we need to select editors that encourage more risk-taking. This means publishing papers that ask interesting economic questions even if the result is negative. There are two motivations here. First, a paper with a Bayesianized p-value of say 0.30 might be addressing an important economic question that provides insights no matter what the result is. Second, the effect might be true. To reduce Type II errors, the editor needs to be willing to take some risk. Indeed, as an extreme example, no editor wants to reject the next Black-Scholes paper.

Moreover, editors should not simply chase impact factors. It is well-known that there are fixed effects across different areas of financial economics (as well as other sciences). This should not lead editors to shun papers in certain areas. The individuals tasked with selecting journal editors should ensure that the prospective editor has a long-term view for the journal.

In addition, top national conferences and journals in financial economics should follow the lead of other fields and accept "registered reports."[26] These reports are detailed proposals that involve, say, the collection of new data or a plan to do research in an unexplored field. Such a proposal is like the front end of the usual paper as it provides economic motivation as well as a plan detailing the methods to be employed once the data are collected. The proposal is peer reviewed, with the editor making a decision as to whether the research question is interesting enough to publish—even if the result is negative. It is understood that the researcher will inevitably need to make certain choices when confronted with issues not anticipated in the original proposal. These choices must be made transparent in the final paper. Registered reports effectively reduce researchers' downside risk, increasing their incentives to undertake otherwise risky projects.

There should also be greater costs associated with p-hacking. In our field, very few replication studies are published, for at least three reasons. First, there is a perception that, given most of the data used in our field are readily available, there is no need to replicate. Second, replication studies involve time-consuming editorial back-and-forth with the original authors but are unlikely to lead to many citations, which reduces editorial support for such studies. Third, replication studies are not treated like regular papers in promotion and tenure decisions, which decrease researchers' incentives to conduct these studies. Additionally, the cost of replication needs to decrease. Currently, only the

[26] The 2017 *Journal of Accounting Research* conference implemented this idea.

Journal of Finance requires that computer code be submitted when a paper is accepted, and none of the top journals in finance require data. However, a relatively new journal, *Critical Finance Review*, has made considerable progress in making replication more mainstream.

If the top journals in our field routinely publish papers with negative results as well as replication studies, the number of papers published in these journals will necessarily increase.[27] Such a step is controversial but increasingly feasible as print journals have only a few years to go before being completely replaced by digital versions. The fact that most journals have gone to a multiple-editor system should also help in this regard.

X. Concluding Remarks

The scientific outlook of financial economics crucially depends on our research and publication culture. As Hubble (1954, p. 41) argues,

> The scientist explores the world of phenomena by successive approximations. He knows that his data are not precise and that his theories must always be tested. It is quite natural that he tends to develop a healthy skepticism, a suspended judgment, and a disciplined imagination.

This means that, as a researcher, you must be skeptical of both conventional wisdom and your own beliefs.[28] Importantly, you are not a sales person—you are a scientist. Yet how many of our papers include language such as "this result is encouraging?"[29] Such language is unscientific and reveals to the reader that the researcher has a specific agenda to find evidence in support of his or her hypothesis. This is the type of culture that motivates my address.

The title of my address is borrowed from Bertrand Russell's (1931) famous treatise, *The Scientific Outlook,* which I believe should be required reading for all Ph.D. students in financial economics or other sciences. In that work, Russell argues for caution in the presentation of results:

> Who ever heard of a theologian prefacing his creed, or a politician concluding his speeches, with a statement as to the probable error in his opinions? It is an odd fact that subjective certainty is inversely proportional to objective certainty. The less right a man has to suppose himself

[27] *PNAS* publishes more than 3,100 peer-reviewed papers each year in weekly issues. *PLoS ONE* published 28,107 peer-reviewed papers in 2015—more papers on any weekday than the *Journal of Finance* publishes in one year (in 2015, the *Journal of Finance* published 70 articles). Obviously, the number of potential contributors is greater for *PLoS ONE*.

[28] See also Gawande (2016).

[29] I checked. In particular, I searched the top three journals in finance over the period 2000 to 2015 for the word "encourag*." I then examined the context of each instance identified and isolated the papers that use phrases like "encouraging results." I found 29 instances of such phrases in the *Journal of Finance,* 22 in the *Journal of Financial Economics*, and 19 in the *Review of Financial Studies*.

> in the right, the more vehemently he asserts there is no doubt whatever that he is exactly right . . . No man who has the scientific temper asserts that what is now believed in science is exactly right; he asserts that it is a stage on the road towards the exact truth (pp. 64–65).

We are living in an era of increased mistrust about scientific discovery (Gauchat (2012)). Some of this mistrust is well founded. It is hard to interpret the results of pharmaceutical clinical trials, for instance, when those that do not work out are not made public.[30] I previously mentioned the exaggerated published result that couples that meet online are happier. To add to that story, the data were provided by eHarmony, where one of the authors was an employee. In our own field, credibility suffered after the global financial crisis when the documentary *Inside Job* suggested that sponsored research potentially misled investors.[31]

It is hard to undo such damage. Whether it is the widely discredited study that claimed power lines cause cancer or the fraudulent study in *The Lancet* that argued there is a link between the preservative in vaccines and autism, it is difficult to debunk bad science. Indeed, recent work suggests that efforts to debunk bad studies may have the opposite effect (Cook and Lewandowsky (2012)), actually increasing beliefs in the false results.

Most of us would agree that, today, the quality of research in financial economics is high. However, my address is not about today—it is about tomorrow. To avoid stumbling down the same path as some other fields, it is essential that we build and maintain a robust research culture. While there is work to do, the scientific outlook of financial economics is very promising. My modest goal here is to start a conversation about some of the issues that I have raised in this address.

REFERENCES

Alter, Adam L., and Daniel M. Oppenheimer, 2006, Predicting short-term stock fluctuations by using processing fluency, *Proceedings of the National Academy of Sciences* 103, 9369–9372.

American Finance Association, 2016, Code of Professional Conduct and Ethics. Available at http://www.afajof.org.

American Statistical Association, 2016, Statement on Statistical Significance and P-Values. Available at: https://www.amstat.org/asa/files/pdfs/P-ValueStatement.pdf.

Bayarri, M. J., Daniel J. Benjamin, James O. Berger, and Thomas M. Sellke, 2016, Rejection odds and rejection ratios: A proposal for statistical practice in testing hypotheses, *Journal of Mathematical Psychology* 72, 90–103.

Bayarri, M. J., and James O. Berger, 1998, Quantifying surprise in the data and model verification, in José M. Bernardo, James O. Berger, A. Philip Dawid, and Adrian F. M. Smith, eds.: *Bayesian Statistics*. Vol. 6. (Oxford University Press, Oxford).

Bem, Daryl J., 2011, Feeling the future: Experimental evidence for anomalous retroactive influences on cognition and affect, *Journal of Personality and Social Psychology* 100, 407–425.

[30] Organizations such as http://alltrials.net are trying to force companies to reveal results of all scientific trials.

[31] The study in question is titled "Financial Stability in Iceland."

Berger, James O., and Thomas Sellke, 1987, Testing a point null hypothesis: The irreconcilability of p values and evidence, *Journal of the American Statistical Association* 82, 112–122.

Berk, Jonathan, Campbell R. Harvey, and David A. Hirshleifer, 2017, How to write an effective referee report and improve the scientific review process, *Journal of Economic Perspectives* 31, 231–244.

Berkson, Joseph, 1938, Some difficulties of interpretation encountered in the application of the chi-square test, *Journal of the American Statistical Association* 33, 526–536.

Berkson, Joseph, 1942, Tests of significance considered as evidence, *Journal of the American Statistical Association* 37, 325–335.

Cacioppo, John T., Stephanie Cacioppo, Gian C. Gonzaga, Elizabeth L. Ogburn, and Tyler J. VanderWeele, 2013, Marital satisfaction and break-ups differ across on-line and off-line meeting venues, *Proceedings of the National Academy of Sciences* 110, 10135–10140.

Carver, Ronald P., 1978, The case against statistical significance testing, *Harvard Educational Review* 48, 378–399.

CERN, 2017, LHC: The guide, Conseil Européen pour la Recherche Nucléaire, January. Available at http://cds.cern.ch/record/2255762/files/CERN-Brochure-2017-002-Eng.pdf.

Churchill, Gary A., 2014, When are results too good to be true? *Genetics* 198, 447–448.

Cohen, Jacob, 1994, The earth is round (p<.05), *American Psychologist* 49, 997–1003.

Coles, Jeffrey, Naveen Daniel, and Lalitha Naveen, 2008, Boards: Does one size fit all? *Journal of Financial Economics* 87, 329–356.

Comte, Auguste, 1856, *The Positive Philosophy of Auguste Comte*, translated by Harriett Marineau (Calvin Blanchard, New York). Vol. II. Available at: https://doi.org/10.1017/CBO9780511701467.

Consolidated Standards of Reporting Trials, 2010. Available at http://www.consort-statement.org/consort-2010.

Cook, John, and Stephan Lewandowsky, 2012, *The Debunking Handbook* (University of Queensland, St. Lucia, Australia). Available at: http://www.skepticalscience.com/docs/Debunking_Handbook.pdf.

Edwards, Ward, Harold Lindman, and Leonard J. Savage, 1963, Bayesian statistical inference for psychological research, *Psychological Review* 70, 193–242.

Fama, Eugene F., and Kenneth R. French, 1992, The cross-section of expected stock returns, *Journal of Finance* 47, 427–465.

Fama, Eugene F., and Kenneth R. French, 2015, A five-factor asset pricing model, *Journal of Financial Economics* 116, 1–22.

Fama, Eugene F., and James D. MacBeth, 1973, Risk, return, and equilibrium: Empirical tests, *Journal of Political Economy* 81, 607–636.

Fanelli, Daniele, 2010, "Positive" results increase down the Hierarchy of the Sciences, *PLoS ONE* 5, e10068.

Fanelli, Daniele, 2012, Negative results are disappearing from most disciplines and countries, *Scientometrics* 90, 891–904.

Fanelli, Daniele, 2013, Positive results receive more citations, but only in some disciplines, *Scientometrics* 94, 701–709.

Fisher, Ronald A., 1925, *Statistical Methods for Research Workers* (Oliver and Boyd Ltd., Edinburgh).

Francis, G., 2012, Too good to be true: Publication bias in two prominent studies from experimental psychology, *Psychonomic Bulletin and Review* 19, 151–156.

Gauchat, Gordon, 2012, Politicization of science in the public sphere: A study of public trust in the United States, 1974–2010, *American Sociological Review* 77, 167–187.

Gawande, Atul, 2016, The mistrust of science, Commencement speech, California Institute of Technology, reprinted in *The New Yorker*. Available at http://www.newyorker.com/news/news-desk/the-mistrust-of-science.

Gelman, Andrew, and Eric Loken, 2013, The garden of forking paths: Why multiple comparisons can be a problem, even when there is no "fishing expedition" or "p-hacking" and the research hypothesis was posited ahead of time, Working paper, Columbia University. Available at: http://www.stat.columbia.edu/˜gelman/research/unpublished/p_hacking.pdf.

Gelman, Andrew, and Eric Loken, 2014, The statistical crisis in science, *American Scientist* 102, 460–465.

Gelman, Andrew, and Hal Stern, 2006, The difference between “significant” and “not significant” is not itself statistically significant, *The American Statistician* 60, 328–331.

Gigerenzer, Gerd, 2004, Mindless statistics, *Journal of Socio-Economics* 33, 587–606.

Goodman, Steven N., 1993, P values, hypothesis tests, and likelihood: Implications for epidemiology of a neglected historical debate, *American Journal of Epidemiology* 137, 485–496.

Goodman, Steven N., 1999, Toward evidence-based medical statistics. 1: The *p*-value fallacy, *Annals of Internal Medicine* 130, 995–1004.

Goodman, Steven N., 2001, Of *p*-values and Bayes: A modest proposal, *Epidemiology* 12, 295–297.

Greenhouse, J. B., 2012, On becoming a Bayesian: Early correspondences between J. Cornfield and L. J. Savage, *Statistics in Medicine* 31, 2782–2790.

Harvey, Campbell R., Yan Liu, and Heqing Zhu, 2016, . . . and the cross-section of expected returns, *Review of Financial Studies* 29, 5–68.

Head, Alex, Gary Smith, and Julia Watson, 2009, Would a stock by any other ticker smell as sweet? *Quarterly Review of Economics and Finance* 49, 551–561.

Head, Megan L., Luke Holman, Rob Lanfear, Andrew T. Kahn, and Michael D. Jennions, 2015, The extent and consequences of *p*-hacking in science. *PLoS Biol* 13, e1002106.

Hubble, Edwin, 1954, *The Nature of Science and Other Lectures* (Huntington Library, San Marino, California).

Hutton, Jane, 2010, Misleading statistics: The problems surrounding number needed to treat and number needed to harm, *Pharmaceutical Medicine* 24, 145–149.

Ioannidis, John P. A., 2005, Why most published research findings are false, *PLoS Medicine* 2, e124.

Ioannidis, John P. A., 2008, Why most discovered true associations are inflated (with discussion), *Epidemiology* 19, 640–658.

Jarosz, Andrew F., and Jennifer Wiley, 2014, What are the odds? A practical guide to computing and reporting Bayes factors, *Journal of Problem Solving* 7, 2–9.

Kerr, Norbert L., 1998, HARKing: Hypothesizing after the results are known, *Personality and Social Psychology Review* 2, 196–217.

Lang, Janet M., Kenneth J. Rothman, and Cristina I. Cann, 1998, That confounded *p*-value (Editorial), *Epidemiology* 9, 7–8.

Lintner, John, 1965, The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets, *Review of Economics and Statistics* 47, 13–37.

Marsh, David M., and Teresa J. Hanlon, 2007, Seeing what we want to see: Confirmation bias in animal behavior research, *Ethology* 113, 1089–1098.

Mossin, Jan, 1966, Equilibrium in a capital asset market, *Econometrica* 34, 768–783.

Newey, Whitney K., and Kenneth D. West, 1987, A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix, *Econometrica* 55, 703–708.

Neyman, Jerzy, and Egon S. Pearson, 1933, On the problem of the most efficient tests of statistical hypotheses, *Philosophical Transactions of the Royal Society* Series A 231, 289–337.

Nosek, Brian A., Jeffrey R. Spies, and Matt Motyl, 2012, Scientific utopia: II. Restructuring incentives and practices to promote truth over publishability, *Perspectives on Psychological Science* 7, 615–631.

Nuzzo, Regina, 2014, Statistical errors, *Nature* 506, 150–152.

Ritchie, Stuart J., Richard Wiseman, and Christopher C. French, 2012, Failing the future: Three unsuccessful attempts to replicate Bem’s ‘retroactive facilitation of recall’ effect, *PLoS ONE* 7, e33423.

Rosenthal, Robert, 1979, The “file drawer problem” and tolerance for null results, *Psychological Bulletin* 86, 638–641.

Royal Swedish Academy of Sciences, 2013, Press release, October 8. Available at http://www.nobelprize.org/nobel_prizes/physics/laureates/2013/press.html.

Russell, Bertrand, 1931, *The Scientific Outlook* (The Free Press, Glencoe, Illinois).

Sever, Peter S., Björn Dahlöf, Neil R. Poulter, Hans Wedel, Gareth Beevers, Mark Caulfield, Rory Collins, Sverre E. Kjeldsen, Arni Kristinsson, Gordon T. McInnes, Jesper Mehlsen, Markku

Nieminen, Eoin O'Brien, and Jan Östergren, 2003, Prevention of coronary and stroke events with atorvastatin in hypertensive patients who have average or lower-than-average cholesterol concentrations, in the Anglo-Scandinavian Cardiac Outcomes Trial—Lipid Lowering Arm (ASCOT-LLA): A multicentre randomised controlled trial, *The Lancet* 361, 1149–1158.

Sharpe, William F., 1964, Capital asset prices: A theory of market equilibrium under conditions of risk, *Journal of Finance* 19, 425–442.

Simonsohn, Uri, Leif D. Nelson, and Joseph P. Simmons, 2014, *P*-curve: A key to the file-drawer, *Journal of Experimental Psychology: General* 143, 534–547.

Song, Fujian, A. J. Eastwood, Simon Gilbody, Lelia Duley, and A. J. Sutton, 2000, Publication and related biases, *Health Technology Assessment* 4, 1–115.

Srinivasan, Raji, and Nita Umashankar, 2014, There's something in a name: Value relevance of congruent ticker symbols, *Consumer Needs and Solutions* 1, 241–252.

Trafimow, David, and Michael Marks, 2015, Editorial, *Basic and Applied Social Psychology* 37, 1–2.

Wasserstein, Ronald L., and Nicole A. Lazar, 2016, The ASA's statement on *p*-values: Context, process, and purpose, *The American Statistician* 70, 129–133.

Welch, Ivo, and Amit Goyal, 2008, A comprehensive look at the empirical performance of equity premium prediction, *Review of Financial Studies* 21, 1455–1508.

Yermack, David, 1996, Higher market valuation of companies with a small board of directors, *Journal of Financial Economics* 40, 185–212.

Exhibit 49

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TRADING, COMMUNICATION AND THE RESPONSE OF ASSET PRICES TO NEWS*

James Dow and Gary Gorton

In this paper we explore the link between asset price changes and the arrival of news. Keynes' beauty contest, and unexplained price movements such as stock market crashes, illustrate a disquiet in the economics profession that asset price movements often appear to bear little relationship to changes in fundamentals. Recent empirical work suggests that the trading process itself is the mechanism for information exchange. Stock return variances are higher during trading hours than during non-trading hours, and longer trading hours are associated with higher trading volume (see Oldfield and Rogalski, 1980; French and Roll, 1986; Meese, 1986; Barclay *et al.* 1990). Our model is designed to emphasise that the price change following the arrival of news need not be a quick, smooth response. The pattern of the price response over time may be so complicated that there is no apparent relationship between the arrival of new information and the price.

We allow for learning via trading and consider the response of price over time when there are multiple informed traders and an information structure which is intended to capture the notion that information is difficult to interpret. The potentially complex price response is caused by the complexity of the information that the traders receive. In order to illustrate this we model an example of an information structure with the property that news may cause the price to fall initially and then rise. This reversal of the price path corresponds to traders initially believing that the news is bad and then revising their valuations in light of the other traders' reactions.

Apparently unusual price paths may occur when the information differs from the standard 'truth plus noise' paradigm in which each agent receives a private signal equal to the true value plus an error term. Then the exchange of information leads to averaging the individual valuations. The 'truth plus noise' structure leads to a price response in which, on average, the initial reaction is followed by successively smaller responses in the same direction. Our information structure shows that this is not true in general. Consider the following illustration.

Cray Research is a leading manufacturer of supercomputers. In 1989 Seymour Cray, the founder of the company, was engaged in a large research project to develop a new computer technology which if successful would give the company a strong competitive advantage. The company however, had not

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decided whether to continue research on the project and Mr Cray was considering leaving to found a separate company.[1]

Consider two analysts, one of whom learns whether Mr Cray is leaving the firm or not while the other has an advantage in evaluating the new technology. The possible outcomes are as follows: (1) Mr Cray stays and the technology is successful in which case Cray stock will have a high value; (2) Mr Cray stays and the project fails in which case the stock will have a low value; (3) Mr Cray leaves and the project is successful in which case Cray stock will have a low value; (4) Mr Cray leaves but the project fails leaving Cray Research as the dominant firm and hence highly valued.

Suppose the analysts' prior beliefs are that Mr Cray will stay and that the project will succeed. What happens if one analyst learns that Mr Cray is likely to leave, and the other analyst studies the technology and decides that it is more likely to fail than is generally recognised in the market? After receiving his private signal, each analyst believes the shares are of low value. If each sells Cray stock, the price will fall. Realising that the low price reflects sales by the other trader, each infers the signal received by the other trader and revises his valuation upwards. Then buying causes the price to rise again. There is a price reversal as the information is revealed through trading. While this particular reversal is rather special, the general point is that complex price dynamics can emerge when the interpretation of agents' signals depends on the information received by other agents.

I. THE MODEL

We consider an asset market in which two informed traders interact with each other and with a downward sloping noisy linear demand curve. There are three trading periods, followed by a final period in which the value of the asset is realised and consumption takes place.[2] In period 0 the market opens but no information has been received. Then the two traders receive private signals about the value of the asset. In period 1 they trade on the basis of this information. In period 2 traders have an opportunity to trade based on their inferences from the period 1 price.

Each informed trader receives a private signal, A or B. If both get the same signal the value of the asset, V, will be 1. If they receive different signals, $V = 0$. The chance of signal A, α, exceeds $\frac{1}{2}$ and is independent of the other signal. Thus A represents 'good news' on its own, but in order to evaluate it fully the trader needs to know the other signal. Note that the unconditional (period 0) valuation is $\alpha^2 + (1-\alpha)^2$.

There is a probability $(1-\delta) \in (0, 1)$ that the asset value will be publicly revealed immediately after period 1. The characterisation of the equilibrium in period 2 will be conditional on the information not being revealed. Otherwise

[1] See *Business Week*, April 30 1990.

[2] Within each period the model is analogous to a standard Cournot duopoly, but one where the sellers have private information about the common, unknown, production cost. In our model the demand curve will also adjust to reflect past information, as will be seen.

the informed traders have no advantage in period 2, and the price will simply reflect the true value.

Let Q_t^j be the quantity sold by trader j in period t (a negative value of Q_t^j represents a purchase).[3] S^j denotes trader js signal, A or B.

Trader js strategy is a rule for choosing Q_t^j, described by a triple $\langle q_0, q_1(S^j), q_2(S^j, P_1, Q_{1j})\rangle$.[4] q_0 is the quantity sold in period 0. In period 1 the trader sells $q_1(A)$ if A was received, and $q_1(B)$ if B. In period 2 the quantity depends on the expected value of the asset, and on the prediction of the other trader's period 2 quantity. These are inferred from trader js own signal, his period 1 quantity, and the period 1 price. (Note the distinction between uppercase Q, denoting an arbitrary quantity, and lowercase q denoting the quantity prescribed by the trader's strategy.)

The payoff to a trader is the expected value of his final holding of the asset, less the amount of money paid to acquire the position. This may be decomposed into the sum of per-period payoffs, where the payoff in each period is the difference between the expected value of the assets acquired and the amount of money paid for them (and *vice versa* in the case of a sale).

The two informed traders face a noisy downward sloping demand curve,

$$P_t = a_t - bQ_t + \epsilon_t,$$

where $\epsilon_t \sim \mathrm{N}(0, \sigma^2)$.[5] Note that the intercept is the expected price if the informed traders do not trade. We assume that it adjusts over time so that uninformed speculators cannot enter and make excess returns. In particular, in period 2 the intercept depends on the period 1 price. This is a market efficiency condition. The slope and the error term may be interpreted as representing agents with random transitory alternative investment opportunities. They may be willing to sell an undervalued financial asset in order to invest in superior real alternatives (children's college, daughter's wedding, family business, etc). They are willing to pay a premium to satisfy these 'liquidity needs' but they are not willing to pay any price, hence the finite slope. We consider limiting equilibria as the variance of the noise tends to zero.

In equilibrium an informed trader has an incentive to spread his trades over both remaining periods because the market is not infinitely deep. His period 1 trade affects the price and so provides the other trader with information about his signal. Symmetrically, he will learn from the period 1 price about the other trader's signal. This gives an additional incentive to restrict period 1 quantities, because of the desire to deceive other traders.

We now discuss the symmetric Nash equilibrium of the model. For reasons of space we omit the detailed derivation of the equilibrium strategies and give

[3] There are no restrictions on borrowing and short sales.

[4] We describe the symmetric Nash equilibrium of the game, so the equilibrium strategies are not indexed by j.

[5] Since our focus in this paper is on the effect of information exchange on the price path, we adopt a simple exogenous price-formation process. The main requirement for our analysis is a price-formation institution which raises the price when people buy and lowers it when people sell. Modelling price formation is a difficult theoretical problem; there are a number of models which are less *ad hoc* than the one we use here, but they are sufficiently complicated that they would be intractable in the present setting. See Kyle (1985) and Glosten and Milgrom (1985).

only the briefest description. We also omit some of the proofs of results. The details are available in Dow and Gorton (1991).

Equilibrium in period 0 may be solved independently of the other periods. The expected price is equal to the expected value, $\alpha^2+(1-\alpha)^2$, and the informed traders do not trade ($q_0 = 0$).

Periods 1 and 2 are connected and the equilibrium solution is derived recursively. In period 2, trader j has beliefs that the other agent has the same signal. This probability that the other agent has the same signal is also equal to the expected value of the asset (since $V = 0$ or 1), conditional on the agent's information. We denote this expectation by:

$$E_2^j(V \mid S^j, Q_1^j, P_1).$$

Here the superscript j on the expectation denotes the agent who is forming the expectation, and the subscript $t = 1, 2$ denotes the time period. This belief about the other agent's signal is also used to predict the other trader's period 2 quantity, given that the other trader is playing the equilibrium strategy. Together with trader js period 2 quantity, this allows him to predict the period 2 price:

$$E_2^j(P_2 \mid S^j, Q_1^j, P_1, Q_2^j).$$

Trader j then chooses Q_2^j to maximise his payoff. We define $u_2^j(S^j, P_1, Q_1^j)$ to be the value function giving the period 2 payoff:

$$u_2^j(S^j, P_1, Q_1^j) = \max_{Q_2^j} [E_2^j(P_2 \mid S^j, Q_1^j, P_1, Q_2^j) - E_2^j(V \mid S^j, Q_1^j, P_1)]\, Q_2^j.$$

The expected value of period 2 profit, after choosing period 1 quantities but before the period 1 price is known, is:

$$\begin{aligned} U_2^j(S^j, Q_1^j) &= E[u_2^j(S^j, P_1, Q_1^j)] \\ &= \int_{\mathbb{R}} u_2^j(S^j, P_1, Q_1^j)\, \phi(P_1)\, dP_1, \end{aligned}$$

where $\phi(P_1)$ is the density of P_1.[6]

The profit from period 1 is:

$$U_1^j(S^j, Q_1^j) = [E_1^j(P_1 \mid S^j, Q_1^j) - E_1^j(V \mid S^j)]\, Q_1^j.$$

In period 1, trader j chooses Q_1^j to maximise the sum of the period 1 payoff and the value of the period 2 payoff:

$$\max_{Q_1^j} U_1^j(S^j, Q_1^j) + \delta U_2^j(S^j, Q_1^j).$$

The period 2 value enters because his period 1 quantity will affect the price and reveal information about his signal. It is possible to derive a closed-form

[6] The density can be derived from the normal distribution of the error term, together with the distribution of the possible quantities traded by the other trader (as a function of his signal). See Dow and Gorton (1991) for details.

solution for the period 2 equilibrium strategies. It can then be shown that the optimal period 1 quantity for trader j, given that the other trader (trader i) plays the equilibrium strategy $q_1(S^i)$, is

$$Q_1^j = \{a_1 - b[\alpha q_1(A) + (1-\alpha)\, q_1(B)] - \mathrm{E}_1^j(V \mid S^j) - (\delta b/\sigma^2)\,\mathrm{Cov}\,[u_2^j(S^j, P_1, Q_1^j), P_1]\}/2b, \qquad (1)$$

and that

$$a_1 = a_0 + 2b[\alpha q_1(A) + (1-\alpha)\, q_1(B)] \qquad (2)$$

by the market efficiency condition. The expression for the optimal quantity may be viewed as follows: the first part, $a_1 - b[\alpha q_1(A) + (1-\alpha)\, q_1(B)]$, is the expected price for trader js first (infinitesimal) unit traded. The second part, $\mathrm{E}_1^j(V \mid S^j)$ is trader j's expectation of the asset value. The third part, $(\delta b/\sigma^2)\,\mathrm{Cov}\,[u_2^j(S^j, P_1, Q_1^j), P_1]$, represents the effect of trader js period 1 trade on his period 2 payoff: by restricting his period 1 quantity, he reveals less information about his signal and increases his period 2 payoff. In equilibrium the optimal quantity, as given by the above expression, must equal $q_1(S^j)$.

II. BELIEF AND PRICE REVERSALS

We will describe the equilibrium price paths as a function of the different combinations of private signals. We focus on the case when the two traders each receive a B signal. The equilibrium price path in this case illustrates the effect of learning with our information structure: the period 1 price will be low, but will be followed by a high period 2 price.

Suppose that both traders receive signal B. In period 1 both traders believe the asset is more likely to be worth zero than one, and so they will sell the asset. Conversely if they both receive good news (signal A) they will buy the asset. This implies that when both traders receive B signals the period 1 price will, on average, be lower than the period 0 price.

In period 2 both traders will probably have observed a low price in period 1. They will tend to infer that the other trader also received a B signal. This implies that the asset is valuable, so they will both revise their beliefs upwards. In addition, since the low period 1 price is publicly observable, the rest of the market will also tend to infer that both traders received B signals and demand will shift upwards. The price in period 2 will tend to be high. So long as the amount of noise is sufficiently low, there will be a reversal: the average price in period 2 will exceed the period 0 price.[7].

In order for any learning to occur, traders must submit different quantities when they receive different signals. It is straightforward to show that this is the case.

PROPOSITION 1. $q_1(A) \neq q_1(B)$.

[7] A weaker type of reversal occurs if expected period 2 price exceed the expected period 1 price, but is less than the expected period 0 price. This will happen if the noise in the market is too large, so that the market price does not communicate much information. By supposing the amount of noise is small we can focus on cases where the period 2 expected price does reflect the correct valuation relative to the period 0 price.

Proof. The proof is by contradiction. If $q_1(A) = q_1(B)$ then no learning occurs, and a trader who deviated in period 1 would only affect his period 1 profit. He would not affect the other trader's inferences. We therefore show that if $q_1(A) = q_1(B)$, such a deviation would be profitable. There are three possible cases:

Case (i): $q_1(A) = q_1(B) = 0$. Since there is no inference from the period 1 price, $U_2^j(A, x) = U_2^j[A, q_1(A)]$ for all quantities x. But for small $x > 0$, $U_1^j(A, x) > 0 = U_1^j[A, q_1(A)]$. In other words, A is good news so the trader can profit in period 1 by buying the asset.

Case (ii): $q_1(A) = q_1(B) < 0$. Again there is no inference from the period 1 price, so $U_2^j(B, 0) = U_2^j[B, q_1(B)]$. But $U_1^j(B, 0) = 0 > U_1^j[B, q_1(B)]$. In other words, a trader who receives a B signal has no incentive to take a loss in period 1.

Case (iii): $q_1(A) = q_1(B) > 0$. This is analogous to case (ii). ■

We now address the direction of the inferences from the period 1 price. We show that traders tend to sell on bad news and buy on good news. This implies that a trader who observes a high period 1 price infers that the other trader received an A signal, and conversely for a B signal.

PROPOSITION 2. $q_1(A) < q_1(B)$.

Proof. Again the proof is by contradiction. Suppose that $q_1(A) > q_1(B)$, so that the probability a trader received a B signal is strictly increasing in the period 1 price. First, note that each trader wants to conceal his information because this leads to more favourable period 2 price. Therefore, if $q_1(A) > q_1(B)$, a trader with a B signal prefers a lower period 1 price and a trader with an A signal prefers a higher period 1 price. In other words $U_2^j(A, Q_1^j)$ is decreasing in Q_1^j, and $U_2^j(B, Q_1^j)$ is increasing in Q_1^j.

Second, observe that $q_1(A) > q_1(B)$ implies that either (i) $q_1(A) > 0$ or (ii) $q_1(B) < 0$ (or both).

Case (i): $q_1(A) > 0$. Since $U_2^j(A, Q_1^j)$ is decreasing in Q_1^j, if the trader deviates from equilibrium by trading nothing in period 1 instead of $q_1(A)$, then period 2 value rises: $U_2^j(A, 0) > U_2^j(A, Q_1^j)$. But period 1 profit rises: $q_1(A) > 0$ implies $U_1^j[A, q^1(A)] < 0$. Consequently $U_1^j(A, 0) = 0 > U_1^j[A, q^1(A)]$.

Case (ii): $q_1(B) < 0$. This is symmetric to case (i). ■

The intuition underlying this result is straightforward. If the traders react to good news initially by selling the asset, then each could unambiguously benefit by deviating: he could simultaneously increase profit in period 1, and increase period 2 profit by manipulating others' beliefs about his signal. Equilibrium requires that the immediate benefits of trading in period 1 be balanced against the subsequent costs of revealing information. This can only happen if $q_1(A) < q_1(B)$. An immediate consequence is that if both traders receive B signals, the period 1 price will fall compared to the period 0 price. If they both receive A signals the price will rise.

Since the period 1 price depends on the quantities traded, which depend on the signals, traders learn from the price. Their beliefs about the each other's signal and about the asset value will, on average, be updated in the right direction.

PROPOSITION 3. (i) *If both traders get B signals, then each trader's expected valuation in period 2 is greater than the expected valuation in period 1.*

(ii) *If both traders get A signals, then each trader's expected valuation in period 2 is greater than in period 1.*

(iii) *If the traders get different signals, then each trader's expected valuation in period 2 is less than in period 1.*

The proof is omitted. Case (i) shows that it is possible that information can initially be interpreted by the informed traders as bad news, and subsequently be viewed as good news. The reversal is not due to noise: in order to make the comparison we averaged out the noise in the system.

We now show that if both traders receive B signals a reversal may occur in which, on average, the period 2 price exceeds the period 0 price, while the period 1 price is less than the period 0 price. Proposition 3 shows that traders' beliefs are revised upwards after period 1, but this does not necessarily mean that they are revised above the initial beliefs $(E_1^j(V|B) = 1-\alpha)$. The reversal of the price path will only occur if sufficient learning takes place. Since the model has only two periods after the information arrives, if the demand function is too noisy traders will not learn enough.

PROPOSITION 4. *Consider the limit of the equilibrium as σ^2 tends to zero, in the event that both traders receive B signals. The expected period 1 price is less than the expected period 0 price. The expected period 2 price is greater than the expected period 0 price.*

Proof. Period 1: If both traders receive signal B they each choose $q_1(B)$. By Proposition 2, $q_1(B) > \alpha q_1(A) + (1-\alpha) q_1(B)$. Thus

$$E(P_1 | BB) = a_1 - b[2q_1(B)] < a_1 - b(2)[\alpha q_1(A) + (1-\alpha) q_1(B)] = E(P_0),$$

where the latter equality follows since a_1 is determined by the market efficiency condition. Period 2: Suppose that as $\sigma^2 \to 0$ the equilibrium quantities $q_1(A)$ and $q_1(B)$ are bounded away from each other. Then in the limit learning is complete. In particular if each trader received a B signal and chooses $q_1(B)$,

$$E_2^j(V | B, P_1) \to 1,$$
$$E(V | P_1) \to 1.$$

The first statement means that, in the limit, the informed traders infer each other's signal perfectly from the price. The second statement says that even an uninformed observer would learn perfectly. Hence by the market efficiency condition

$$E(P_2 | BB) \to 1 > E(P_0).$$

Now suppose that as $\sigma^2 \to 0$ the equilibrium quantities $q_1(A)$ and $q_1(B)$ become arbitrarily close. We will show by contradiction that this is impossible.

If period 1 quantities are arbitrarily close then expected period 1 profits are arbitrarily small. On the other hand the period 2 profits cannot exceed δ times the maximum possible period 1 profit-since period 2 profit is the same as period 1 profit if no learning occurs, and less otherwise. Thus a trader would be better off by maximising period 1 profit and ignoring the effect on period 2. This contradicts the initial hypothesis. ■

III. CONCLUSION

When information is difficult to interpret, the price response may display a pattern which bears little resemblance to the final valuation of the asset, or to the date at which information arrived. These price dynamics can be explained by information exchange via the trading process. We have given one example of an information structure with two traders which can display an apparently anomalous price path. In general, information structures which differ from the standard 'truth-plus noise' paradigm can result in a rich pattern of price responses, while remaining consistent with rationality.

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REFERENCES

Barclay, M., Litzenberger, R. and Warner, J. (1990). 'Private information, trading volume, and stock return variances.' *Review of Financial Studies*, vol. 3, no. 2, pp. 233–54.

Dow, J. and Gorton, G. (1991). 'Trading, communication and the response of price to new information.' Working paper no. 3687, National Bureau of Economic Research.

French, K. and Roll, R. (1986). 'Stock return variances: the arrival of information and the reaction of traders.' *Journal of Financial Economics*, vol. 17, pp. 5–26.

Glosten, L. and Milgrom, P. (1985). 'Bid, ask and transaction prices in a specialist market with heterogeneously informed traders', *Journal of Financial Economics*, vol. 14, pp. 71–100.

Kyle, A. S. (1985). 'Continuous auctions and insider trading.' *Econometrica*, vol. 53, pp. 1315–35.

Meese, R. (1986). 'Testing for bubbles in exchange markets: a case for sparkling rates?' *Journal of Political Economy*, vol. 94, no. 2, pp. 345–73.

Oldfield, G. and Rogalski, R. (1980). 'A theory of common stock returns over trading and non-trading periods.' *Journal of Finance*, vol. 35, pp. 729–51.

Exhibit 50

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Robust inference in single firm/single event analyses[☆]

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ABSTRACT

Single firm/single event (SFSE) studies are relevant in corporate finance. Since inference on abnormal returns in this context necessarily relies on the time series variance of these abnormal returns, the implied problem of heteroscedasticity is obvious, although hard to solve. We analyze robust inference in an SFSE setting using Monte Carlo and resampling experiments. Estimation is biased when the calibration and event period occur in different volatility regimes. We develop a unique specification test for these structural breaks. The most robust inference is obtained by using intraday data and a multiplicative component GARCH estimator.

1. Introduction

Event studies based on a single time series of stock returns and a single economic event (Single Firm/Single Event, SFSE) have received scant attention in the academic literature, despite their relevance in corporate finance. SFSE analysis methodology differs from standard event studies in that inference on abnormal returns can only be based on the time series variance of their abnormal returns over a calibration period. The implied problem of heteroscedasticity when detecting statistically 'unusual' abnormal returns on event days is evident in this setting. The solution, however, is not so obvious. Little is known about statistically suitable event study design in an SFSE setting in terms of parametrization and the choice of estimators.

We therefore analyze robust inference in an SFSE setting using Monte Carlo and resampling experiments and conduct size and power tests of different methods in different market volatility regimes. We find that estimation is severely biased when the calibration and event period occur in different volatility regimes, and that such structural breaks occur frequently. Therefore, we develop a

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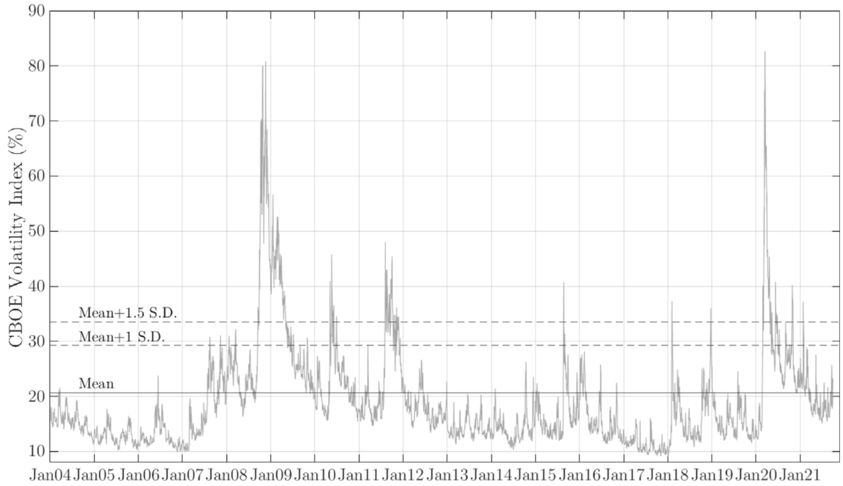

Fig. 1. CBOE Volatility Index.
The figure shows the CBOE Volatility Index (VIX) from January 2004 to November 2021. The solid line represents the mean VIX, the two dashed lines depict the mean plus one (one-and-a-half) standard deviations (S.D.) of the VIX.

unique specification test for these structural breaks and show that in the presence of structural breaks robust inference is obtained by using intraday data and a multiplicative component GARCH estimator.

At first sight, the SFSE setting may appear to be quite specific. But SFSE analysis is relevant in several economic settings, for example:

- *Securities fraud litigation*: under the Securities Exchange Act of 1934, U.S. exchange-listed firms must disclose any major operational, structural, financial, or ownership changes to their shareholders and to the SEC via Form 8-K. If this information is omitted, untimely, or false, parties transacting in the security can be eligible for damage compensation under Rule 10b-5. Under the U.S. Supreme Court's so-called 'fraud-on-the-market' doctrine, the key issues of reliance, materiality, loss causation, and damages require measuring the stock price impact of this information, which requires evidence from SFSE analysis (Fisch et al. 2018). The same principles apply under the EU Market Abuse Regulation (MAR). Securities fraud litigation is of significant economic relevance for firm value and investor wealth in terms of expected and realized penalties from litigation and associated reputation costs (see Karpoff et al. 2008).[3]
- *Determining the materiality of private information*: none of the aforementioned regulations on the mandatory disclosure of issuers' private information specify how to determine a materiality threshold, i.e., the minimum market value impact such that specific private information must be disclosed. SFSE analysis thus provides a means for the issuer to determine this minimum effect magnitude *ex ante*. Using a historical period of trading days as the calibration period to estimate 'normal' abnormal return volatility allows us to predict ex ante the future stock price change that would be statistically significant at the next trading day.[4] Such a materiality threshold would also be pivotal in potential future litigation about a firm's allegedly misleading disclosures. SFSE analysis is thus crucial if issuers are to abide by their disclosure obligations ex ante.
- *Analyzing firm operations*: companies' management, investment, and financing decisions are regularly scrutinized, both by external parties such as rating agencies, analysts, the media, and by the company itself, e.g., with regard to management compensation. The company-specific stock market reaction to such decisions often plays a decisive role in these analyses, again requiring SFSE analysis.

For all these applications, the high sensitivity of SFSE with respect to structural breaks and the associated biased inference is a troublesome phenomenon that potentially invalidates such analyses. In fact, structural breaks do not only occur in extreme market phases (such as the 2008/2009 financial crisis or the fever period during the Covid-19 outbreak[5]) but quite frequently, even without extreme macroeconomic shocks. Fig. 1 depicts the CBOE Volatility Index (VIX) for the years 2004 to 2021, including its mean and

[3] According to the Stanford Law School Securities Class Action database, compensation and settlement payments on the approximately 2500 settlements since 1996 amounted to more than $100 billion. In 2019, there were over 400 new securities fraud class actions in the U.S. (Cornerstone Research 2020). Thus, the (expected) cash flow consequences of potential and actual securities fraud litigation significantly affect firm value. Since litigation outcomes will be heavily affected by event studies, false and biased conclusions about abnormal returns on litigated event days can have dire consequences for firms and/or shareholders.

[4] An event study tests an event's abnormal return for significance by using the estimated abnormal return variance of the calibration period. Thus, the future day (t+1) significance threshold can be determined by using the previous observed abnormal returns for the firm, e.g., from day (t-251) to day t.

[5] The term 'fever period' was coined by Ramelli and Wagner (2020).

standard deviation. Since the volatility index frequently exceeds the one standard deviation distance from the mean (e.g., 15 times over the period 2004 to 2021), significant changes in market volatility cannot be considered rare events. Moreover, structural breaks occur not only at the market level, but also at individual companies due to idiosyncratic shocks. In a sample of 516 S&P500 companies between 2004 and 2021, we estimate a mean of 13.8 (standard deviation = 10.1) regime switches per constituent based on implied volatilities.[6] SFSE studies are therefore likely to be frequently affected by structural breaks both due to systematic or idiosyncratic effects.

In the presence of a structural break, significance tests on abnormal returns on an event day will be biased with regard to the statistical size of the test. This would, for example, yield too many type I errors identifying abnormal returns as unusual when they are not.[7] Intuitively, if an event study's abnormal return variance estimate is driven primarily by a calibration period with low volatility and the event period volatility is high, the SFSE analysis will use an underestimated residual variance for the significance test, resulting in over-rejection. If the calibration period has predominantly high volatility and the event period has low volatility, this will lead to under-rejection.

In general, this misspecified statistical size of event studies in an SFSE setting is a serious problem. Without a remedy, event studies could not reliably be used for any of the aforementioned purposes. For example, in litigation, a biased significance test would systematically lead courts to draw the wrong conclusions about a firm's information policy.

Our study is structured as follows. Section 2 briefly discusses how our study fits in and contributes to the existing literature on event study methodology. In Section 3, we discuss the standard event study methodology in an SFSE setting and the particularities of drawing inference in this setting.

In Section 4, we provide evidence from Monte Carlo simulations about basic design choices for SFSE analyses and the robustness of the resulting inference for abnormal returns. We concentrate our analysis of the SFSE event study design on a setting with heteroscedasticity of abnormal returns[8] and the test size and power of different methods in different market volatility regimes. It turns out that neither heteroscedasticity, nor time-varying volatility, nor extreme levels of volatility lead to problems of inference in terms of type I errors for OLS or GARCH estimations. The sole problem of inference in the SFSE setting arises from switching volatility regimes, where the calibration and event period occur in different regimes.[9]

To identify such regime changes, we develop and analyze a specification test for the presence of a structural break in return volatility based on short return time series as shown in Section 5. This type of specification test is unique in the academic literature. We test the statistical properties of the power and size of this specification test using Monte Carlo simulations. To investigate the practical relevance of structural breaks as well as the suitability of the test procedure with real-world data, we further conduct an extensive resampling experiment and analyze randomly selected fictitious events in a time window of [+2,+8] months after four different types of volatility regime change (as indicated by the VIX index). The specification test systematically detects the presence of a structural break, and if the test reveals a structural break, the resulting inference bias caused by the structural break is particularly pronounced for the stocks in question.

To overcome biases from the presence of structural breaks in the calibration period, we propose using intraday data on stock returns. This significantly shortens the calibration period for an event study, thereby mitigating the risk of the occurrence of a structural break. Intraday data event studies also have a power at least as high as event studies based on daily data and mitigate the problem of confounding events. Our corresponding analysis based on resampling experiments presented in Section 6 shows that the multiplicative component seasonality GARCH model (mcsGARCH, Engle and Sokalska 2012) is the only suitable model for accounting for prevalent intraday volatility patterns, exhibiting well specified statistical size and power.

To illustrate the application of intraday SFSE based on this methodology, we provide a detailed case study of a loss announcement by Hallmark Financial Services, Inc. In this case, the fever period caused by the outbreak of the Covid-19 pandemic in March 2020 leads to distorted inference when using an SFSE analysis based on daily data. The intraday analysis, however, which can be based on the more 'normal' volatility regime after the fever period, provides reliable evidence regarding the market value impact of the company's unexpected loss report. To further assess the importance of controlling for a structural break in daily abnormal returns and relying on an intraday SFSE if a structural break exists, we compare daily and intraday event study results for a sample of S&P500 companies that were the subject of securities fraud class action lawsuits. Section 7 concludes.

Overall, we find that reliable SFSE analyses should be conducted as follows:

1. For data availability reasons and to reduce complexity, first conduct an event study based on daily data.
2. Test for the existence of a structural break in the volatility of abnormal returns using the derived specification test for short time series.
3. If the test indicates the existence of a structural break in the calibration period, use an event study based on intraday data and apply the mcsGARCH estimator.

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[6] A regime switch is defined as a minimum +/− one standard deviation from the mean implied volatility of the company for at least five trading days.

[7] The size of a statistical test measures how often the null-hypothesis is rejected if in fact it is true. For example, if a test is conducted using a 5% significance level, an abnormal return without an announcement effect is expected to be identified as being 'unusually high' in 5 out of 100 cases (in a one-sided significance test).

[8] The analysis of stock returns in Section 4 shows that autocorrelation is not empirically relevant even during the market turmoil at the height of the subprime crisis.

[9] The case of event-induced changes in abnormal return variance is a special case of this problem. Event-induced variance increases have been analyzed in the literature on event study methodology in the standard financial economics setting of analyzing a cross-section of many events, see e.g., Savickas (2003).

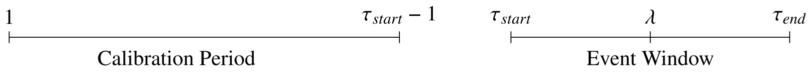

Fig. 2. Time structure of an SFSE regression.
The figure shows the time structure of an SFSE regression, depicting the event window and a corresponding calibration period.

2. Relevant literature

Event studies – introduced by Fama et al. (1969) – are widely used in financial economics to measure the impact of new information on companies' market values (Campbell et al. 1997, Kothari and Warner 2007). Methodological extensions in the literature deal mainly with providing robust methods for inference, e.g., when the analyzed event leads to variance increases for abnormal returns (Brown and Warner 1985, Boehmer et al. 1991, Corrado 1989, Savickas 2003), applying GARCH-models to deal with time-varying volatility (De Jong et al. 1992, Savickas 2003), or investigating the impact of estimation errors on inference (Salinger 1992). Aktas et al. (2007) and Marks and Musumeci (2017) look at contaminated calibration periods, analyzing a large cross-section of events.

Our study contributes to this strand of the literature by analyzing statistical inference when the calibration period of an event study based on daily data is subject to strong heteroscedasticity and time-varying volatility, when a structural break occurs in the abnormal return volatility, and by devising a specification test for such structural breaks. These aspects are particularly critical in single firm single event analysis, since the statistical significance of abnormal returns is based on the time series of a single company's stock returns (Fisch et al. 2018) rather than on the distribution of a large cross-section (e.g., MacKinlay 1997).

Due to the U.S. Supreme Court's 'fraud-on-the-market' doctrine, event study methodology has also become relevant to litigation, particularly in the context of securities fraud class actions alleging violations of SEC Rule 10b-5. This has motivated some academic litigation research, including studies discussing issues with confounding events during the event period, tests for multiple events, and difficulties in selecting the correct event date (Brav and Heaton 2015, Fisch et al. 2018, Fisch and Gelbach 2021, Mitchell and Netter 1994, Torchio 2009). Empirical results by Baker (2016) indicate that SFSE analyses using daily data underestimate standard errors during the 2008/2009 financial crises.

Our study contributes to this part of the literature by providing (to the best of our knowledge) the first systematic analysis of a suitable SFSE design for robust inference in general, and by determining the relevance and severity of the biases caused by structural breaks in SFSE analysis based on daily data.

Finally, due to the problem of structural breaks in SFSE based on daily data, we develop and analyze a framework for conducting robust *intraday* event studies in the SFSE context, including their application to litigation cases. This also contributes to the scarce general literature on intraday event studies (Mucklow 1994), by operationalizing the multiplicative component seasonality GARCH (mcsGARCH) model developed by Engle and Sokalska (2012), and testing its statistical properties in the SFSE setting.

3. SFSE method and applicable estimators

3.1. Event study method in SFSE

In an event study, the abnormal return of a security's stock price is tested for a statistically significant realization. Abnormal returns are defined as the actual return on a given day minus the expected ('normal') return of that security. The most common (and theoretically grounded) method for estimating the expected return is the market model, i.e., an empirical implementation of the theoretical Capital Asset Pricing Model (CAPM) (Sharpe 1963). In an SFSE setting, estimating the normal return, calculating abnormal returns, and testing for significance are conducted in one step using the following regression approach:

$$r_i - r_f = \beta_0 + \beta_1 \cdot \left(r_{index} - r_f\right) + \sum_{m=1}^{M} \beta_{m+1} \cdot EventDummy_m + \varepsilon_i, \tag{1}$$

where r_i is the security's return, r_{index} is the index return as the proxy for the theoretical market portfolio, and r_f is the risk-free interest rate. Returns are thus measured as excess returns such that β_0 is the average security return unexplained by the market factor, β_1 is the security's 'beta'-factor, and ε_i is the error term or abnormal security return. The beta-factor reflects the extent to which the security returns move on average with the index returns. To conduct the event study on daily data, abnormal returns on specific dates (the event window) are tested for statistical significance by including a dummy variable ($EventDummy_m$) for each event m in Eq. (1). The event window consists of $\tau = \left[\tau_{start}, \tau_{end}\right]$ of length τ for each event. Each event dummy is set to zero for days in the calibration period, and to τ^{-1} on days in the event window.[10] Fig. 2 shows the time structure of the model for one event.

[10] For the sake of brevity, we rely on a single event day instead of an event window comprising several days. All of the methods discussed can be easily adjusted to an event period, and none of our results with daily data depend on using a single event day. Intraday event studies, discussed in Section 6, by definition use an event window of several minute-intervals but do not span several trading days.

The fundamental difference between an SFSE analysis and the method financial researchers typically use when conducting event studies is the determination of the statistical significance of an event day's abnormal return (Fisch et al. 2018). Event studies in the academic context estimate the influence of one or more events on multiple firms' stock prices. Abnormal returns are either aggregated over time, across securities, or both (e.g., MacKinlay 1997).

Conversely, in the SFSE case, inference is solely based on the single firm's time series. A t-test on the event dummy's coefficient is thus conducted relying on the variance of the abnormal returns, which determine the standard error of the event dummy coefficient ($\sqrt{var(\beta_2)}$). When estimating the model presented in Eq. (1) with only one event, the significance test on β_2 as the event dummy's coefficient is:

$$\Theta_{sfse} = \frac{\beta_2}{\sqrt{var(\beta_2)}} \sim N(0,1). \tag{2}$$

If Eq. (1) is estimated using OLS, two assumptions are made: (1) abnormal security return variance is homoscedastic, hence $E(\epsilon_t^2|X) = \sigma^2$ for each return at time t, and (2) abnormal returns do not exhibit autocorrelation, i.e., $E\left(\epsilon_{t_1}\epsilon_{t_2}|X\right) = 0$ for $t_1 \neq t_2$.

In theory, however, abnormal returns exist due to the information processing of firm-specific information (and perhaps 'noise trading'). Since firm-specific information, by definition, varies over time (and across firms), abnormal returns are necessarily heteroscedastic.[11] In this case, OLS estimates of the abnormal returns remain unbiased, but the variance estimate used for inference is biased.

In the next subsection, we discuss several alternative estimators to OLS that explicitly account for heteroscedasticity (and stochastic volatility), which we use in our analysis of SFSE.

3.2. Estimators accounting for heteroscedasticity and stochastic volatility

3.2.1. White correction of standard errors

The White correction of standard errors (White 1980) is a common method used to account for heteroscedasticity. It is asymptotically unbiased (i.e., consistent) for general types of heteroscedasticity (Greene 2008). Using this correction leaves the coefficients as estimated by OLS, but adjusts the standard errors for heteroscedasticity.

3.2.2. Generalized autoregressive conditional heteroscedasticity

Since stock returns (and abnormal returns, see Appendix A) are empirically characterized by stochastic volatility, another natural choice for robust inference is the use of a generalized autoregressive conditional heteroscedasticity model (GARCH). Since OLS is unbiased with regard to the coefficient estimates (and thus abnormal returns), inference is drawn in a two-step estimation approach. In the first step, residuals (i.e., abnormal returns) are estimated by OLS. In the second step, inference on the event day dummy is based on a GARCH(1,1) model, fitted to the abnormal returns.[12]

The GARCH model (Bollerslev 1986, Engle 1982) is given by:

$$\sigma_t^2 = \omega + \alpha \cdot \epsilon_{t-1}^2 + \beta \cdot \sigma_{t-1}^2. \tag{3}$$

The ARCH parameter α indicates the influence of prior abnormal returns or innovations ϵ_{t-1}^2, which we assume are t-distributed, on today's volatility σ_t^2. The GARCH parameter β describes the influence of prior volatility σ_{t-1}^2 on today's volatility.

As Eq. (3) shows, the volatility for day t deterministically follows from the estimated parameters and data of day $t-1$. Using a GARCH model for inference therefore allows us to draw inference on the event day abnormal return without actually having to estimate the residual conditional variance on that day.[13]

The t-statistic for testing the null hypothesis of a zero abnormal return on the event day thus uses the coefficient of the event dummy (b_2) from the standard OLS regression (Eq. (1)) and the square root of the expected variance of the abnormal returns for day t. The expected λ-days-ahead variance in a GARCH(1,1) model is:

$$E(\sigma_{t+\lambda}^2) = V_L + (\alpha+\beta)^\lambda(\sigma_t^2 - V_L), \qquad \text{with } V_L = \frac{\omega}{1-\alpha-\beta}, \tag{4}$$

where V_L describes the unconditional variance.

Inference is then based on:

$$t_{GARCH} = \frac{\hat{b}_2}{\sqrt{E(\sigma_{t+\lambda}^2)}}. \tag{5}$$

[11] See e.g., Giaccotto and Ali (1982) for corresponding evidence.

[12] In unreported tests, we also estimated the Glosten et al. (1993)-model (GJR-GARCH). It incorporates a leverage effect, assuming a difference between the influence of negative and positive shocks (abnormal returns) on volatility. Both in the normal and the crisis period, the leverage effect turned out to be statistically insignificant for almost all stocks. This also holds true for our analysis of intraday data in Section 6.

[13] Section 4 will demonstrate that the White correction cannot handle the sparse event dummy vector. The covariance matrix estimate is highly ill-conditioned, leading to severely misspecified size characteristics. The two-step procedure theoretically alleviates this problem as it can be used to infer the standard error of the event day without actually including this observation in the GARCH estimation.

3.2.3. Other methods

Several additional estimators can theoretically account for the heteroscedasticity of abnormal returns. These comprise robust regressions,[14] feasible generalized least squares (FGLS),[15] and bootstrapping.[16]

We do not provide details or results from the Monte Carlo simulations of these methods when dealing with a daily return frequency, as they turned out to be heavily misspecified in terms of the size of the method (robust regressions and FGLS). With these methods, false positive rejections of abnormal returns in the SFSE setting occurred with relative frequencies that differ considerably from the expected value under a 5%-significance level. Bootstrapping results are very close to OLS results, and its use therefore provides no new insights.

4. Statistical properties of different SFSE designs

4.1. Overview

We use Monte Carlo simulations to analyze the performance of the different estimators. First, we simulate data calibrated on observed return characteristics in different macroeconomic environments. Second, we apply the estimators presented above to the simulated data in a standard setting, i.e., using a one-year calibration period and one event day. Finally, varying the calibration period characteristics, in particular the length of the calibration period and the extent of different volatility regimes in the calibration period, allows us to test the sensitivity of the estimators and to identify a well-defined event study design that provides appropriate test sizes and high test power.

4.2. Monte Carlo simulation design and parametrization

To introduce the heteroscedasticity of abnormal returns, we simulate data based on a GARCH(1,1) process assuming t-distributed innovations with 5 degrees of freedom. We simulate $S = 50{,}000$ paths, hence S time series of the calibration period plus one event day for each specification. The parametrization is based on the real data characteristics of 29 U.S. Dow Jones Industrial companies, as presented in Appendix A.

We simulate data for three different volatility scenarios: 'normal', 'medium', and 'crisis'. Our 'normal' scenario is based on a one-year period of data starting on August 09, 2006.[17] The one-year 'crisis' period starts on September 01, 2008, i.e., shortly before the bankruptcy of Lehman Brothers on September 15. For our 'medium' scenario, we use characteristics that lie between the two more extreme scenarios. Table 1 shows the respective specifications. The standard deviation refers to the square root of the unconditional variance within the time series of each daily abnormal return e and index return r_{index}. The beta-factor b_1 is constant within each path and varies between paths with a standard deviation of 0.3. We assume that the characteristics of b_1 are the same in all three scenarios. The specification of the beta-factors results in a 90% confidence interval of approximately $[0.5, 1.5]$. We then apply $r_i = b_1 \cdot r_{index} + e$ to construct the daily stock returns r_i.

We conduct the Monte Carlo simulation with different settings: (i) using constant GARCH volatility processes with different levels of long-run volatility ('normal', 'medium', and 'crisis'), and (ii) switching, i.e., mixed volatility levels. For the mixed volatility time series there are two general cases: first, the initial part of the calibration period is characterized by the comparatively low volatility of abnormal returns, while the latter part features higher volatility of abnormal returns ('low-to-high'). The second case is the reverse pattern ('high-to-low'). In both cases, the event day abnormal return belongs to the same volatility regime as the second part of the calibration period. We combine fractions between 1/12 and 11/12 of each two out of the three regimes into the calibration period. We thus consider the following six cases: 'normal-to-crisis', 'normal-to-medium', 'medium-to-crisis', 'crisis-to-normal', 'medium-to-normal', and 'crisis-to-medium'.

We then test each path using the SFSE regression from Eq. (1) using White, GARCH, and standard OLS inference for comparison. The event days are all pseudo event days. We should therefore find that there is no unusual abnormal return on the event day (except by chance), which corresponds to the null hypothesis. Since the null hypothesis is true by definition with simulated data, the rejection frequency of the null hypothesis using pseudo events should match the significance level. Testing the null hypothesis at a 5% significance level should therefore correspond to rejecting 5% of the pseudo events (size test, testing $H_0 : b_2 = 0$). Furthermore, we conduct a power test by adding a 5% abnormal return to the event day return. The rejection frequencies will show the extent to which actual abnormal returns are detected in the hypothesis tests. For the power test, instead of applying a two-sided t-test to draw inference as in the size test, we apply a one-sided t-test, testing the hypothesis that $b_2 > 0$.

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[14] Robust regressions weigh observations to reduce the impact of outlier observations on the model's estimation. Numerous weighting schemes are available. We tested the Andrews and Huber weighting schemes, see for example Huber (1981).

[15] FGLS is a variant of weighted least squares: in a first step, we consistently estimate regression residuals. In a second step, we assume a specific covariance structure for the regression residuals. Weighting observations by the estimator of the residual variances gives a consistent estimator of standard errors. We tested a common variant, assuming an autoregressive structure with one lag of residuals. See e.g., Greene (2008).

[16] With bootstrapping, regression residuals or pairwise observations of y and X are repeatedly drawn with replacement to generate bootstrap samples of errors or observations. Using the bootstrap sample to repeat the regression analysis and repeating this many times provides a distribution of coefficient estimates that we can use to assess the coefficients' standard errors, see Efron and Tibshirani (1993). We also tested the so-called 'wild' bootstrap as suggested by Mammen (1993), which is specifically designed to capture all types of heteroscedasticity in the underlying errors.

[17] In July 2007, three Bear Stearns subprime mortgage funds failed. In early August 2007, BNP Paribas suspended its redemption in three investment funds due to difficulties valuing the funds. Both events are frequently interpreted as the beginning of the subprime crisis, see e.g., Brunnermeier (2009).

Table 1
Monte Carlo simulation — data characteristics.

Variable	Volatility period		
	Normal	*Medium*	*Crisis*
'beta'-factor	$\mu = 1,\ s.d. = 0.3$	$\mu = 1,\ s.d. = 0.3$	$\mu = 1,\ s.d. = 0.3$
σ^2 of r_{index}	$0.1^2/252$	$0.25^2/252$	$0.4^2/252$
σ^2 of ε	$0.15^2/252$	$0.25^2/252$	$0.4^2/252$
β	0.5	0.6	0.8
α	0.1	0.1	0.1
ω	$0.4 \cdot 0.15^2/252$	$0.3 \cdot 0.25^2/252$	$0.1 \cdot 0.4^2/252$
degrees of freedom	5	5	5

The table shows the input characteristics for simulating daily data. The normal (crisis) volatility characteristics are based on the real return characteristics of 29 U.S. Dow Jones Industrial companies and on the S&P500 Index in the period August 09, 2006–August 08, 2007 (September 01, 2008–August 31, 2009). See Appendix A for more details. The medium volatility characteristics are chosen between the two extremes. For the beta-factor, the standard deviations reflect the fluctuations between simulation rounds, since they are constant for each path. The simulated beta-factors are the same for all three periods. $s.d.$ refers to the standard deviation, μ to the mean, σ^2 refers to the unconditional variance (V_L), β to GARCH, α to ARCH, and ε to innovations. ω, i.e., the constant, results from $(1 - \beta - \alpha) \cdot \sigma^2$.

Table 2
Pure volatility regimes — size and power test for different estimation methods.

	Normal period			Crisis period		
	OLS	*White*	*GARCH*	*OLS*	*White*	*GARCH*
	Size Test					
Average abnormal return	−0.000	−0.000	−0.000	−0.000	−0.000	−0.000
Rejection rate of H_0 (5%)	0.055	0.846	0.052	0.057	0.846	0.049
	Power Test					
Average abnormal return	0.050	0.050	0.050	0.050	0.050	0.050
Rejection rate of H_0 (5%)	0.997	0.999	0.995	0.669	0.999	0.499

The table shows the Monte Carlo simulation results of the size tests for the two different pure volatility regimes (normal and crisis). It shows mean rejection frequencies of the null hypothesis such that the event dummy coefficient b_2 equals zero, i.e., $H_0 : b_2 = 0$, at a 5% significance level using OLS, White, and GARCH with a calibration period of 252 days and one event day. The abnormal return on the event day is set to 5%.

4.3. Examination of different estimation methods

To examine different estimation methods and calibration periods, we only depict the two more extreme volatility regimes 'normal' and 'crisis'. The 'medium' scenario will be presented only when looking at mixed volatility regimes, as the degree of volatility change plays a decisive role in that case. Table 2 firstly shows that abnormal return estimations are unbiased, since the average event dummy coefficient basically equals zero in the size and 5% in the power test. Secondly, both OLS and GARCH work similarly well. This result has one important implication, i.e., introducing heteroscedasticity with realistic volatility levels in 'normal' times and in times of market turmoil does not affect rejection frequencies. In the power tests, the added 5% abnormal return on the event day corresponds to approximately 5.3 daily abnormal return standard deviations in the normal period and 2 daily abnormal return standard deviations in the crisis period. This leads to a higher power in the normal period (close to 100% for all calibration period lengths) than in the crisis period (between 50 and 70%), as in the normal period 5% added returns are more 'abnormal' compared to the respective calibration period returns.

The White correction for heteroscedasticity[18] leads to rejection frequencies of more than 80% instead of the true type I error of 5%. Thus, if a financial economist relies on the White correction to reach a conclusion in a securities fraud lawsuit, the event study result would almost always show a significant event effect, even if there is in fact no unusual abnormal return on the event days. The reason for the strong bias of inference using the White correction is that the sparse event dummy with only zeros and one value of 1 leads to an ill-conditioned[19] variance–covariance estimation and a severe underestimation of standard errors.[20]

Overall, OLS or GARCH estimation exhibit well-behaved statistical size properties under heteroscedasticity in the SFSE setting, even in times of market turmoil.

[18] The Newey–West correction of standard errors (Newey and West 1987) is an extension of the White estimator that is asymptotically robust to heteroskedasticity and autocorrelation. As it is based on the same covariance estimator but includes variants of this matrix for different lags, it is even more affected by the sparse event vector problem than the White estimator. However, abnormal return autocorrelation in the normal period (0.0005) and in the crisis period (0.0202) using one lag is low and not significantly different from zero as estimated using the Ljung–Box Q-test (Ljung and Box 1978). The fact that we do not consider autocorrelation of returns is therefore not a drawback to our analysis.

[19] The condition number κ is defined by the relation between the highest and lowest singular values of a symmetric matrix. The condition number describes the sensitivity to errors in, or the extent of the well- or ill-conditioning of, a problem (e.g., Strang 2009): $\kappa = \frac{\varsigma_{max}}{\varsigma_{min}}$.

[20] More specifically, the average condition number of variance–covariance matrices using White in the Monte Carlo simulation above is $\kappa\left(var_{White}(b)\right) = 5.14{\cdot}10^{19}$, which is extremely high since a condition number of > 20 is already considered as being large (Greene 2008).

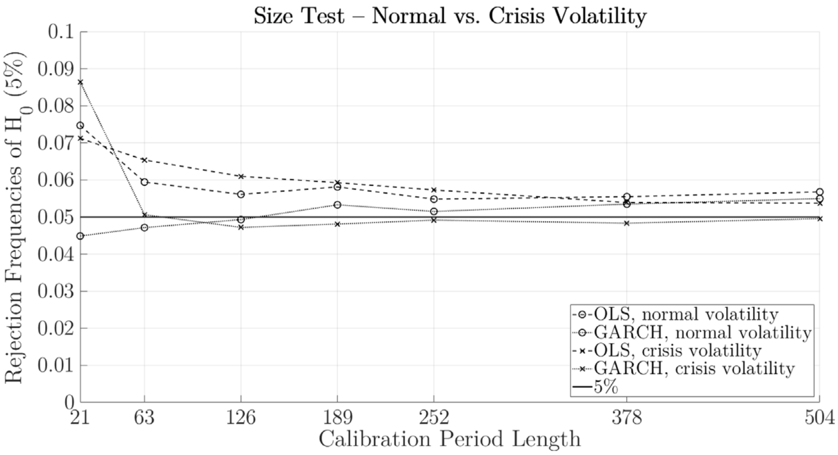

Fig. 3. Pure normal vs. crisis volatility regimes — size test.
The figure shows the rejection frequencies of the null hypothesis that the event dummy coefficient b_2 equals zero, i.e., $H_0 : b_2 = 0$, at a 5% significance level using standard OLS and GARCH for different calibration period lengths for the simulated normal and crisis volatility regimes. Calibration period lengths are as follows: 21 days (1 month), 63 days (3 months), 126 days (0.5 year), 189 days (0.75 year), 252 days (1 year), 378 (1.5 years), and 504 (2 years). The 5% line serves as a reference for the expected type I error.

4.4. Examination of calibration period lengths

Setting the length of the calibration period is a decision that involves two different issues in an SFSE setting. First, when the calibration period is longer, more data will be used for estimating the model, leading to a more precise estimation from a purely statistical point of view. Second, when the calibration period is shorter, the estimated normal return and variance will be more specific to the 'economic' period within which the event occurs. This becomes most relevant in the case of regime shifts, for example in the case of the subprime crisis. The challenge is therefore to choose a calibration period that is both economically and statistically feasible.

Fig. 3 shows the rejection frequencies using OLS and GARCH for different calibration period lengths. They show rather similar results starting at calibration periods of 6 months and exhibit little change for calibration periods of 9 months or more. As seen in the prior subsection, introducing heteroscedasticity with realistic volatility levels in 'normal' and 'crisis' periods does not affect the rejection frequencies. Additionally, rejection frequencies are only strongly affected for very short calibration periods. The frequently used calibration period of 1 year (i.e., about 252 trading days) appears to be a reasonable choice.

Power tests reveal that power is higher in the normal volatility period than in the crisis volatility period and that there are basically no differences between the different methods in the normal volatility case, while GARCH has a lower power compared to OLS in the crisis volatility case. Detailed results on size and power tests are shown in Appendix B.

4.5. Examination of calibration periods with structural breaks

A well-known problem in standard event studies relates to event-induced variance increases of event day abnormal returns (see e.g., Boehmer et al. 1991, Savickas 2003). A related but more general case is the problem that abnormal returns in the calibration period and around the event period are subject to different volatility regimes, i.e., when there are structural breaks in abnormal return volatility. Intuitively, if the variance estimate is mostly driven by a calibration period with a low volatility regime and the event period volatility is high, the residual variance used for the significance test will be underestimated, which leads to over-rejection. If the calibration period is mostly a high volatility regime and the event period is in a low volatility regime, this will result in under-rejection.

We test the severity of such mixed volatility regimes on the size of different estimators in Monte Carlo simulations. We apply a 1-year calibration period, as the prior subsection confirmed this as a reasonable choice. Calibration periods are constructed with the three types of pure volatility regimes, using 1 to 11 months of one volatility regime plus the rest of the calibration period and the event day of another volatility regime. For example, the first 6 months of the normal volatility regime and the second 6 months plus the event day of the crisis volatility regime are taken to construct a mixed volatility regime with a regime shift in the middle of the calibration period.

Fig. 4 shows the results for the two most extreme changes and one example for a moderate change in volatility (see Appendix C for more detailed results on all six scenarios). OLS shows a convergence to the 5% line with an increasing share of event day regime calibration period returns. An event day in a normal period decreases the rejection rate and an event day in a crisis period increases the rejection rate of $H_0 : b_2 = 0$, as expected. GARCH shows a different pattern from OLS, with an under-rejection for

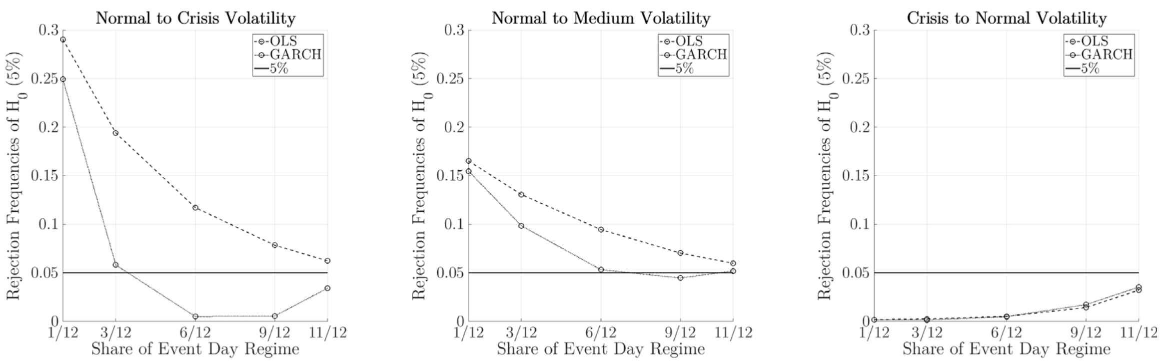

Fig. 4. Mixed volatility regimes — size test.
The figure shows the rejection frequencies of the null hypothesis that the event dummy coefficient b_2 equals zero, i.e., $H_0 : b_2 = 0$, using OLS and GARCH for different mixed calibration period combinations at a 5% significance level. The calibration period length is 252 days. The x-axis shows the share of the event day regime in the 1-year calibration period. This means, in the 1/12 case, that the first 11 months of the calibration period are from the non-event day volatility regime. The final month of the calibration period is from the same volatility regime as the event day. The 5% line serves as a reference for the expected type I error.

many specifications. GARCH overestimates the expected volatility if the estimated unconditional variance is much higher than the actual abnormal return variance of the input data. By definition, unconditional variances are high if the sum of the GARCH and ARCH parameters is close to 1. In such cases the expected volatility is overestimated, which leads to under-rejection. This occurs, in particular, in settings where a rather low-volatility regime switches to a rather high-volatility regime and the event occurs in a crisis volatility period. For more moderate changes of volatility regimes (both 'normal-to-medium' and 'medium-to-crisis'), GARCH converges towards the 5% significance line slightly faster than OLS, showing e.g., rejection frequencies of approximately 5% starting at a minimum 50% share of event day regime. In cases of volatility changes starting in a higher volatility regime with an event occurring in a lower volatility regime, GARCH performs very similarly to OLS.

Overall, the results show that mixed volatility regime calibration periods lead to erroneous type I errors for both OLS and GARCH. However, the reasons for the failure are different. OLS under-rejects if part of the calibration period is in a higher volatility regime than the event. OLS over-rejects if part of the calibration period is in a lower volatility regime than the event. GARCH under-rejects whenever the sum of the estimated GARCH and ARCH parameters is close to 1, leading to very large unconditional volatilities and therefore to high expected event window volatilities. This happens in particular when volatility strongly increases over the calibration period. In settings with only a moderate increase in volatility over the calibration period, GARCH over-rejects less frequently than OLS. In settings with both moderately or strongly decreasing volatility over the calibration period, GARCH under-rejects to a similar extent as OLS.

To conclude, all of the analyzed estimators are severely biased in the presence of most mixed volatility calibration periods. Under these circumstances, using event studies based on daily data is not feasible as conclusions on the significance of abnormal returns are systematically wrong.

5. Detecting structural breaks in the volatility of abnormal returns

5.1. *A statistical test of structural breaks for short time series*

As shown in the previous section, changes in the volatility regime during the calibration period lead to significantly distorted inference results in SFSE analyses. For practical applications, it is therefore important to identify the existence of such structural breaks in a statistically reliable manner to avoid drawing false conclusions about the stock price development on an event day.

In the literature, there are numerous suggestions about performing specification tests for structural breaks in time series. However, they are usually not tested or applied for such short stock return time series as the calibration period in an event study. Accordingly, our simulation analyses indicate that both the structural break tests LM and CUSUM (Smith 2008, unreported) and the GARCH misspecification test proposed by Chuffart et al. (2018) have virtually no power to detect structural breaks using one year of daily return data.[21]

In the following, a specification test specific to the SFSE context is developed to identify structural breaks in the volatility of abnormal returns. This specification test is based on the simple idea that, in the case of a regime change, the observation period is divided into (at least) two time periods, where extreme returns occur more frequently in the higher volatility period. This means that these relative outlier returns (or synonymous anomalies) must occur in a temporally coherent pattern, i.e., they will be clustered in the high volatility phase. Thus, to test for structural breaks in the volatility regime, an outlier identification algorithm is applied in

[21] For the results of applying the Chuffart et al. (2018) test, please refer to Appendix D.

Table 3
Size and power of the test for structural breaks in the volatility of abnormal returns in the calibration period.

Panel A: Size test			
Share of event day regime	Normal	Medium	Crisis
100%	0.024	0.025	0.084
Panel B: Power test			
Share of event day regime	Normal to Crisis	Normal to Medium	Medium to Crisis
10%	0.300	0.094	0.101
20%	0.811	0.260	0.305
30%	0.971	0.426	0.539
40%	0.993	0.525	0.676
	Crisis to Normal	Crisis to Medium	Medium to Normal
10%	0.307	0.106	0.133
20%	0.765	0.319	0.271
30%	0.966	0.555	0.428
40%	0.995	0.686	0.532

The table reports the detection frequency of structural breaks for different pure and mixed volatility calibration periods, based on 10,000 simulated abnormal return paths with 253 observations for each setting. Volatility regimes are defined in Table 1. Panel A shows the size of the structural break test since the simulated returns do not have a structural break in the pure 'Normal', 'Medium', and 'Crisis' scenarios. Panel B shows the power of the structural break test, when abnormal returns first have lower and then higher volatility, and vice versa.

the first step and each daily abnormal return is marked accordingly. In the second step, the temporal correlation of the identified outliers is measured. If outliers occur within a time cluster, i.e., show a strongly pronounced temporal correlation pattern, this indicates a structural break.

For the first step, i.e., outlier detection, we apply the 'isolation forest' algorithm (see Liu et al. 2012). The isolation forest algorithm does not model 'normal' observations first, before identifying anomalies as deviations from the normal. It instead directly attempts to isolate anomalies without relying on distance or density measures. Any sample of observations is broken down into groups by binary trees (isolation trees) until a certain level of observation separation is reached. Since anomalies are less frequent and should have fewer similar neighbors relative to the 'normal' data, the number of binary subdivisions for the separation of an outlier observation is smaller (the isolation path length), and anomalies have the shortest path lengths.

To determine the temporal clustering of outlier returns, we use a non-parametric Spearman rank correlation between a dummy indicating outlier observations and a time index. Its statistical significance is determined by bootstrapping the isolation forest scores of abnormal returns 100 times and measuring rank correlation each time.

5.2. Monte Carlo evidence on the power and size of the structural break test

Table 3 shows the application of the described specification test in a set of Monte Carlo simulations, which are characteristic for SFSE analysis. We again differentiate between the three volatility levels, 'crisis', 'medium', and 'normal' and simulate corresponding GARCH(1,1) processes with t-distributed error terms (see Table 1 for the parameters). The scenarios have unconditional return volatility of 40%, 25%, and 15% p.a., respectively. In scenarios with a structural break, the proportion of observations of the event day regime in the calibration period varies between 10%–40%. The number of simulations per analyzed scenario is 10,000. Each simulated return time series comprises 253 observations.

Table 3 shows that the proposed specification test for structural breaks in the volatility regime of abnormal returns works well with regard to the size and power statistical properties. Panel A shows that the test is sufficiently well specified if there is no structural break in the simulated return time series. Applying a 5% significance level, the test leads to an average 2%–3% rejection of the null hypothesis that there is no structural break in the 'low' and 'medium' volatility levels. In the 'high' scenario (which is characterized by frequent, very extreme returns due to the t-distribution assumption), the number of false positives is around 8%. Panel B shows that if structural breaks actually occur in the simulated data, the power of the test is pronounced, both in the 'higher-to-lower' direction and in the 'lower-to-higher' direction. Even with a share of only 20% of 'anomalies' in the form of a lower (or higher) volatility level, the test has significant power to identify the structural break, between about 80% ('crisis-to-normal' and 'normal-to-crisis') and 26% ('normal-to-medium').

5.3. Resampling evidence for structural breaks

For the practical application of SFSE analyses, the question is how often the problem of a structural break occurs in the calibration period. As discussed in Section 1, significant regime shifts in market volatility levels occurred about 15 times in the period from 2004 to 2021. With a calibration period length of about one calendar year (252 trading days), each of these shocks could potentially affect an SFSE analysis in an essentially two-year window (i.e., one year before and one year after the regime shift). Further complications stem from the fact that the development of the VIX as a market indicator is only a guide to potentially relevant structural breaks, since these occur even without a regime change in the market for individual companies due to idiosyncratic shocks quite frequently.

Table 4
Resampling evidence on structural breaks.

	Normal to Medium	Medium to Crisis
Breaks	Aug 09, 2007	Sep 01, 2008
Period in which random events are drawn	Oct 09, 2007–Apr 11, 2008	Oct 30, 2008–May 04, 2009
Mean VIX – in 6 months before break	14.8%	22.3%
– in 6 months after break	23.4%	49.6%
– in period in which random events are drawn	24.3%	47.9%
Frequency of detected structural break (%)	0.3680	0.6900
Rejection rate of H_0 (5%) – overall	0.1220	0.1380
– given break detected	0.1576 (N=184)	0.1536 (N=345)
– given no break detected	0.1013 (N=316)	0.1032 (N=155)
Mean coefficient event dummy	0.0006	0.0014
	Crisis to Medium	Medium to Normal
Breaks	May 01, 2009	Jan 01, 2012
Period in which random events are drawn	Jul 02, 2009–Dec 31, 2009	Mar 05, 2012–Aug 31, 2012
Mean VIX in 6 months before break	47.9%	30.3%
– in 6 months after break	26.9%	19.1%
– in period in which random events are drawn	24.3%	18.2%
Frequency of detected structural break (%)	0.6560	0.0620
Rejection rate of H_0 (5%) – overall	0.0140	0.0480
– given break detected	0.0061 (N=328)	0.0000 (N=31)
– given no break detected	0.0291 (N=172)	0.0512 (N=469)
Mean coefficient event dummy	−0.0007	−0.0007

The table reports details of our structural break test. For this test, we used the returns of 29 companies listed in the Dow Jones Industrial Index, randomly drawing 500 fictitious event day-company combinations from a 6-month sample period. For each of the four volatility scenarios, the first two rows present details of the time of the break and the period from which the random events are drawn. The next three rows show mean VIX values around the structural break and in the event day sampling period. The row below that shows the relative frequency of detecting a structural break according to our structural break test. The next three rows show the overall rejection frequency when performing event studies using daily data and standard OLS, as well as a breakdown showing whether a structural break was detected or not. The number of observations within each group is reported in brackets. For completeness, we further report mean event dummy coefficients.

In a sample of S&P500 companies between 2004 and 2021, we estimate a mean of 13.8 (standard deviation = 10.1) regime switches per constituent, based on implied volatilities.

In order to investigate the practical relevance of structural breaks as well as the suitability of the test procedure, we now report the results of a resampling experiment. We analyze randomly selected fictitious events in a time window of [+2, +8] months after a regime change observed on the VIX using 29 constituents of the U.S. Dow Jones Industrial Index (see Section 4). The chosen post-shock time window ensures that the changed volatility regime in which the event occurs comprises 2/12 to 8/12 of the calibration period.

Analyzed regime change incidences for the VIX have been selected beginning on August 09, 2007 (normal-to-medium), September 01, 2008 (medium-to-crisis), May 01, 2009 (crisis-to-medium), and January 01, 2012 (medium-to-normal).[22] For each of these periods, the respective company and the event date were randomly selected (drawn with replacement) and a total sample of 500 fictitious events was examined in each of the four cases.

Table 4 shows the proportion of events with a structural break identified by the test for each period. In line with the results of the Monte Carlo simulation in the previous section, it can be seen that when the volatility difference between the two volatility regimes in the presence of a structural break is higher, the power of the test to indicate this is higher. Since we assume a structural break in each of the phases examined, the frequency of rejections of the null hypothesis (of no structural break) indicates the power of the test.[23] For the change from lower to higher volatility, the rejection rate is 36.80% and 69.00%, respectively, and for the change from higher to lower volatility, the rejection rate is 65.60% and 6.20%, respectively.

The table also shows how often the event studies lead to a type-I error, i.e., the randomly chosen abnormal returns for fictitious events are identified as being significantly different from zero (at a 5% significance level). This is expected to happen more often than at a 5% frequency if the event takes place in a higher volatility regime than at the beginning of the calibration period. Conversely, a rejection rate below 5% is expected if the event is in a lower volatility phase than at the beginning of the calibration period.

Table 4 shows that these patterns can be observed in the resampling experiments. In the normal-to-medium as well as the medium-to-crisis phase, 12.20% and 13.80% of the events are classified as statistically significant, respectively. The downward-biased volatility estimate for the event time caused by the structural break thus leads to a rejection frequency that is systematically

[22] For the selection of these dates, see Fig. 1 for the VIX history, as well as the descriptive statistics for the respective volatility levels in Table 4.
[23] Note that the dates of the fictitious events are randomly drawn from an 8-month period. The fraction of the event day regime in the calibration period thus varies for each firm-event observation.

too high. Similarly, for the crisis-to-medium as well as the medium-to-normal regimes, it can be observed that the type-I error systematically occurs in fewer than 5% of the analyses (1.4% and 4.8%, respectively). These results show that the structural breaks systematically lead to biased inference.

The results in Table 4 also show that the distortions with regard to over-rejection or under-rejection are particularly pronounced when the structural break test indicates a regime change. For the lower-to-higher volatility scenarios, the conditional rejection frequency is higher when the structural break tests indicate a break (e.g., 15.76% vs. 10.13% for normal-to-medium). Conversely, the event study rejection rate conditional on the structural break test result is lower with a break indication than without when the regime change is from higher to lower (e.g., 0.00% vs. 5.12% for medium-to-normal). Both results show the power of the test. When it indicates a structural break, the regime change problem is particularly pronounced for the stock in question. Overall, this means that the number of serious biases could be significantly reduced if the structural break test were systematically used in SFSE analyses.

6. SFSE analysis using intraday data

6.1. Overview and set-up

The Monte Carlo analysis of daily data in Section 4 showed that the key problem in SFSE analyses is accounting for different volatility regimes. If there is insufficient data for calibration in the same volatility regime as the event, significance tests will be flawed. One way of alleviating this problem is to rely on intraday data for the event study. This has several potential advantages:

- *Length of the calibration period*: using intraday data only requires a few days of data for a sufficient number of return observations to provide precise parameter estimates of the event study regression. All other things being equal, it will then be more likely to have a litigation event where the calibration period is in the same economic (volatility) environment as the event day.
- *Power of the test*: event studies based on intraday data have significantly more power to detect an unusual abnormal return if there actually is one (see Mucklow 1994). When the time interval within which the price impact of specific information is measured is shorter, the measurement will be less affected by price reactions due to other information or 'noise' trading also occurring on the event day.
- *Confounding events*: an intraday study allows us to better control for confounding events, i.e., separating the price impact of specific information from price effects caused by other unrelated information that occurs at points in time close to the event.[24]
- *Robustness of standard estimators*: the White and Newey–West corrections of standard errors suffer from an ill-conditioned covariance matrix due to the sparse event dummy vector in the SFSE setting. If the event study were conducted using some intraday data covering several time intervals over which intraday stock price changes were measured (such as 5- or 10-minute intervals[25]), the event dummy might be less sparse and it might be feasible to apply these methods to account for heteroscedasticity and autocorrelation.

However, intraday event studies require the determination of the exact (initial) announcement time of the event, the availability of intraday data, and a correspondingly revised event study design, and are therefore more complex than event studies based on daily returns. Nevertheless, in the presence of a structural break in daily abnormal return volatility, the use of intraday SFSE provides a potential means with which to conduct a reliable SFSE analysis.

It should also be noted that an intraday event study can lead to fundamentally different results regarding the abnormal return of an information event than an analysis of a daily return. First, the event window is by definition shorter in an intraday analysis, so the actual return for the event period changes. Second, on an intraday basis, the expected return in the event period will also be different than on a daily basis, since this 'normal' return estimate (based on the market model) is estimated over a much shorter time period. Accordingly, the beta factor of the market portfolio proxy will also be different than in the event study on a daily basis. Since the abnormal return is the difference between actual and expected return, the abnormal return will therefore also change. However, this generates advantages of intraday event studies, especially in the form of a more precise measurement of the information effect and the reduction of potential influences of confounding events.

In this section we therefore examine the design and statistical properties of SFSE analyses using intraday data.

6.2. Event period length for intraday event studies

Choosing the length of the event window is a challenge in any event study. For event studies on a daily basis, several days are often used as the event period, at least as a robustness test, in order to reduce inaccuracies in capturing the timing of information access to the capital market. However, the disadvantage of a long event period is that this will also capture 'information-less' price movements and this noise will negatively affect the power of the event study. This is basically similar for an intraday event study,

[24] Of course, the timing of the event must be precisely known and it must not occur at exactly the same time as the confounding event.

[25] Note that the aggregation of return data on a transactional level is a standard procedure in academic studies to avoid measurement problems due to the bid/ask-bounce of intraday data.

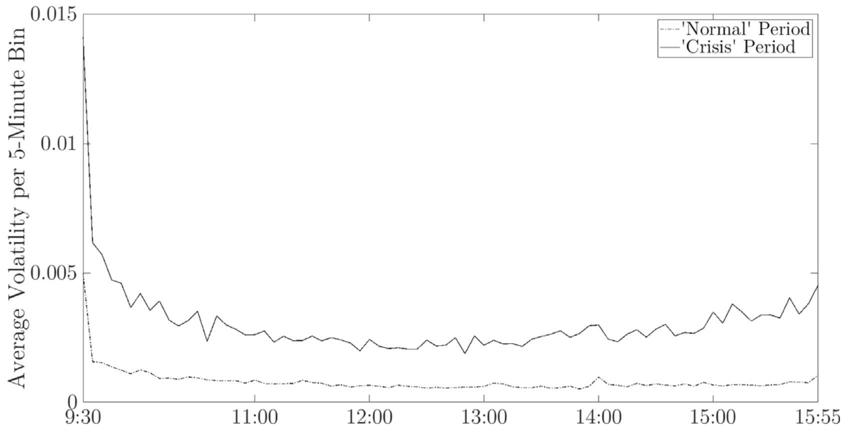

Fig. 5. Intraday volatility pattern during trading hours.
The figure illustrates the pattern of intraday volatility over 5-minute bins of a trading day. Volatility is estimated as the square root of the average squared return of each bin during either the normal or the crisis time periods for 3M Corp. The normal period is from January 2–December 31, 2013. The crisis period is from September 2, 2008–June 30, 2009.

but these can only be meaningfully performed anyway if the information access to the capital market can be identified on a minute basis.

The length of the event period then results from an assumption about the information processing speed of the capital market. On the one hand, this will depend on the complexity of the information and the associated revaluation, i.e., the more complex the issue, the longer it is likely to take to complete processing. On the other hand, academic studies show that through electronic information processing and algorithmic trading, the information processing speed in stock markets is very high. The studies of Busse and Green (2002), Rogers et al. (2017), or Bundesbank (2016) show that new information is usually priced in (and on average correctly) in a few minutes. Anecdotal evidence also shows that even for very complex information events, an event period of no more than two hours is sufficient.[26]

Accordingly, in the following analysis of the design of intraday event studies, we use event periods with a maximum length of two hours.

6.3. Resampling evidence for intraday SFSE analysis

Previous studies have shown that one problem of intraday stock return data is the pronounced seasonal pattern of intraday volatility observable during a trading day. In particular, as for example shown by Engle and Sokalska (2012), the first minutes of the day, which comprise the opening auction, systematically have a higher volatility than the average time-bin (i.e., subintervals of the trading hours, e.g., 5-minute bins). To a lesser extent, the same holds for the final minutes of the trading day (comprising the closing auction). Fig. 5 shows an example intraday volatility pattern for 3M Corp., where the thick line shows the 5-minute-bin volatility during the crisis period (covering the period from September 2, 2008 to June 30, 2009), and the dashed line shows the same pattern for a ‘normal’ period of the full year 2013. The most pronounced difference is between the opening auction time period (which covers the overnight returns from the previous day’s close). For the crisis period, the factor is about 4.6 times larger than the average intraday volatility (a factor of about 6.2 in the normal volatility period).

This volatility pattern might potentially affect the power and size of an SFSE analysis using intraday data. Furthermore, as these patterns are difficult to incorporate into a Monte Carlo simulation, our analysis of intraday SFSE relies on resampling experiments.[27]

In the resampling experiments, we randomly select (with replacement) a sample of 2000 placebo event days for the 29 Dow Jones Industrial Index constituent firms, from either the crisis or the normal volatility period. Trading days where firms made earnings or M&A announcements are excluded. For the market portfolio, we used the S&P1500.[28] For each placebo event, we conducted an SFSE regression, testing the event dummy’s coefficient using either OLS, GARCH, or White standard errors.

Table 5 presents the size test, showing the fraction of cases where the regression analysis using one of the estimators indicates statistical significance at the 5%-level. We differentiate between three different resampling designs, analyzing (i) 24 event-bins (i.e., a 2-hour interval) at the beginning of the trading day (i.e., 09:30 ET), (ii) 24 event-bins at the end of the trading day (i.e., 14:00 ET), and (iii) 12 event-bins also starting at 14:00 ET. This allows us to analyze the extent to which the size of the estimators is

[26] See also the discussion in Section 6.5, where we intensively study serious information events at S&P500 companies that later led to class action suits and compare the results of the daily and intraday measurement for all cases.

[27] The setup and results of a Monte Carlo simulation for intraday SFSE analyses is, however, shown in Appendix E.

[28] We collected earnings announcement dates from I/B/E/S and M&A announcement dates from Thomson Reuters SDC; intraday data is from Bloomberg or kibot.com.

Table 5
Resampling intraday data — size test.

(1) Event	(2) hh:mm	(3) Period	(4) Rejection rate of H_0 (5%)	(5)	(6)	(7)
			OLS	$White$	$GARCH$	$mcsGARCH$
24 bins	09:30	Normal	0.129	0.049	0.111	0.066
		Crisis	0.117	0.049	0.101	0.064
24 bins	14:00	Normal	0.008	0.029	0.008	0.061
		Crisis	0.011	0.018	0.009	0.042
12 bins	14:00	Normal	0.008	0.061	0.008	0.073
		Crisis	0.004	0.057	0.002	0.057

The table shows the results of the size tests for two different pure volatility regimes (normal and crisis) based on resampled intraday data and 2000 placebo events. It shows mean rejection frequencies of the null hypothesis that the event dummy coefficient b_2 equals zero, i.e., $H_0 : b_2 = 0$, using OLS, White, GARCH, and the multiplicative component seasonality GARCH (mcsGARCH) developed by Engle and Sokalska (2012) using a 15-day calibration period. Event periods comprise 12 or 24 5-minute bins starting at the opening (9:30 ET) or the final hours of a trading day (14:00 ET). Significance tests are two-sided with a 5%-significance level.

affected by the intraday volatility pattern and by the actual length (and thus the sparsity of the event indicator in Eq. (1)) of the intraday event period considered. To simplify the exposition, we only report test results of estimator size with a 15-day calibration period. A 10-day calibration period qualitatively leads to the same result and is thus also feasible. However, a 5-day calibration period is too short for reliable inference (results not reported here).[29]

The results shown in Table 5 demonstrate that the OLS, White, and GARCH estimators are affected by the intraday volatility pattern to such an extent that inference is severely biased when using real-world intraday data. For example, OLS overestimates size when applied to placebo events at the beginning of the day with a fraction of type I errors of 12.9% and 11.7% for the normal and the crisis volatility period, respectively. OLS underestimates size when testing at the end of the trading day with a type I error of only about 1%. Size using the White-correction is at 4.9% for the first two hours of the trading day, but way off the target level of 5% if the placebo event is tested at the end of daily trading hours, with 2.9% and 1.8% in the normal and crisis volatility regimes, respectively. Also, the size of the GARCH estimator differs widely between the beginning and the end of the day and generally deviates from the target 5% type I error when using 24 event bins. This differs from the Monte Carlo results with the simulated daily data shown in Section 4.2. Finally, the results shown in the last rows using 12 event bins at 14:00 ET illustrate that the White correction is still affected by the sparse vector problem.

A potential remedy to the bias triggered by the pronounced heterogeneity of intraday volatility during a trading day has been suggested by Engle and Sokalska (2012). The authors suggest a so-called 'multiplicative component seasonality' GARCH model (henceforth mcsGARCH), where the intraday return volatility is driven by a diurnal volatility component s_{bin} (allowing for a different volatility per bin over a day's trading hours) and a daily volatility component, which is a forecast of the next trading day's overall volatility, σ_t. The model is:

$$\epsilon_{t,bin} = (q_{t,bin}\sigma_t s_{bin})z_{t,bin}, \qquad \text{with } s_{bin}^2 = E\left(\frac{\epsilon_{t,bin}^2}{\sigma_t^2}\right), \tag{6}$$

where $z_{t,bin}$ is the i.i.d. random error term at day t and the intraday time-bin bin, $q_{t,bin}$ corresponds to the intraday volatility component, ϵ is the standardized error term of the GARCH Eq. (3), and $E(.)$ denotes the expectations operator. Two steps are required to estimate the mcsGARCH model. In the first step, the diurnal and the daily volatility components (s_{bin} and σ_t) are estimated. In the second step, a standard GARCH(1,1) model (with t-distributed errors) is estimated using the normalized residuals ϵ from Eq. (6).

Engle and Sokalska (2012) give only limited advice on how to estimate the two volatility components (i.e., the diurnal component, s_{bin}, and the next day forecast, σ_t). We ran tests to estimate the diurnal component as either the mean or the median bin-volatility during the calibration period. Unreported results show that the mean of the calibration period's diurnal component works better for both the high and the low volatility period than the median.

We use a two-step approach to estimate the daily volatility component. In the first step, an event firm's realized abnormal return volatility is regressed on the lagged VIX 1-year implied volatility during the calibration period. In the second step, the daily volatility component is predicted from this regression.[30]

Table 5 also shows the results of our resampling test for the mcsGARCH estimator using the mean diurnal component and the daily volatility forecast based on the VIX-value (column 7). The mcsGARCH estimator is shown to be robust against the intraday volatility pattern during both the high and the low volatility regime. It provides reasonable type I error rates close to the target

[29] For the sake of brevity, we do not report test results on the power of estimators, namely for all estimators above 90% when linearly imposing a 5% announcement return.

[30] The two-step approach based on the VIX works better in our resampling experiments than a naive random walk forecast, where the previous day's realized volatility is the prediction for the next trading day.

Table 6
Hallmark case study.

	Panel A: Daily Analysis			Panel B: Intraday Analysis		
Event window:	July 1, 2020			July 1, 2020 9:30–11.30 ET		
Variable	coefficient	t-value	p-value	coefficient	t-value	p-value
Constant	−0.005	−1.367	0.173	0.000	-0.329	0.742
Market (S&P500 Index)	1.578*	8.729	0.000	2.296*	10.344	0.000
Event-Dummy	−0.065	−0.810	0.419	−0.095*	-2.054	0.040
N	251			797		
R^2	0.231			0.121		
Structural break test daily analysis	yes; 95% confidence interval: [0.28,0.58]					

The table shows the event studies regression results for Hallmark Financial Services Inc. on July 1, 2020 (the event day), when the company published unexpected losses for its fourth quarter and for its 2019 fiscal year in SEC EDGAR. Panel A shows results from an SFSE analysis based on daily data, applying GARCH estimation for inference, as described in Section 3.2.2. The specification test described in Section 5 indicates the presence of a structural break in the volatility of abnormal returns during the calibration period. Panel B shows results based on 5-minute-interval intraday data using the mcsGARCH model and a 10-trading-day calibration period, as described in Section 6.3. The intraday event period comprises 24 5-minute bins starting at the stock exchange opening (9:30 ET) on July 1, 2020. Significance tests are two-sided, significance at the 5%-level is indicated by an asterisk.

value of 5% for all three resampling specifications. Hence, unlike all other estimators, the size of mcsGARCH is not affected by the starting point of the event period during a trading day.[31]

Overall, our analysis thus implies that intraday SFSE analysis is highly powerful in identifying actual unusual abnormal returns, has appropriate type I error rates even in the most extreme volatility regimes, and makes it much easier to avoid the problem of having calibration and event periods in different volatility regimes. To be able to exploit these benefits of intraday analysis in an SFSE setting, it is crucial to apply the mcsGARCH estimator suggested by Engle and Sokalska (2012). Our analyses show that the estimator works best if:

- the calibration period is 10 to 15 trading days,
- the diurnal component is calculated as a simple mean of realized bin volatilities during the calibration period, and
- the daily volatility component is based on a security's abnormal return sensitivity against the (lagged) VIX.

Note that mcsGARCH is also unbiased with regard to its size when using it in a Monte Carlo simulation. See Table E.14 in Appendix A.

Thus, even if there are no intraday volatility patterns, mcsGARCH leads to a well-specified estimator size (and high power), making mcsGARCH a universal tool for SFSE analysis based on intraday data.[32]

6.4. Case study: comparing a daily and intraday SFSE analysis in the presence of a structural break

To illustrate the potentially different results obtained when using daily vs. intraday data in the presence of structural breaks, we examine the real-world case of Hallmark Financial Services Inc. (Ticker: HALL), an insurance company listed on the NASDAQ. On June 29, 2020, the company reported an operating loss for its fourth quarter ($36.5 million) and for its 2019 fiscal year ($16.9 million). The market had not expected these losses, as can be seen when comparing the reported loss to the Bloomberg consensus estimate. The Form 8-K regarding these results became public in SEC EDGAR on July 01, 2020 (the event day). As shown in Table 6, when an event study is conducted based on daily data, the event day abnormal return is −6.51% with a t-statistic of −0.81, i.e., the abnormal return is not statistically different from zero, despite its magnitude.[33]

The reason for this result is that the unexpected loss disclosure occurred about three months after the capital market fever period stemming from the Covid-19 pandemic in March 2020. During this fever period, market volatility measured by the VIX index increased from about 14.38% (February 19, 2020) to 82.69% (March 16, 2020) and reverted to a level of about 30% until the end of April 2020. As the fever stage will be part of the event study calibration period for the Hallmark event on July 1, 2020, this constitutes a structural break in volatility, moving from low volatility to high volatility and then reverting to medium volatility. Consistent with this, Table 6 shows that the structural break test suggested in Section 5 is statistically significant.

[31] The disadvantage of resampling is that the crisis period is rather short, with only 8 months of data from which to randomly draw placebo events. This introduces a potential clustering of event days when evaluating the size test, as many randomly drawn placebo events will occur on the same calendar day. Due to this phenomenon, which is only a test design issue and not of relevance for the validity of SFSE analysis, the sample size needs to be relatively small and the measured type I errors may not be exactly equal to 5%, even if an estimator yields unbiased results.

[32] In further unreported resampling exercises, we tested how strongly mcsGARCH is affected by a mixed volatility regime during the 10/15 day calibration period. Mixed volatility regimes have less impact on the size of the estimator when using intraday data than when using daily data, as discussed in Section 4.5. Mixed volatility regimes consistently lead to under-rejection by mcsGARCH, with rejection rates of about 2%–3% instead of the expected 5% for both the 'normal-to-crisis' and the 'crisis-to-normal' patterns.

[33] The daily event study was conducted using the GARCH approach described in Section 3.2.2. Outliers in the calibration period are excluded if an abnormal return is more than four standard deviations from the mean.

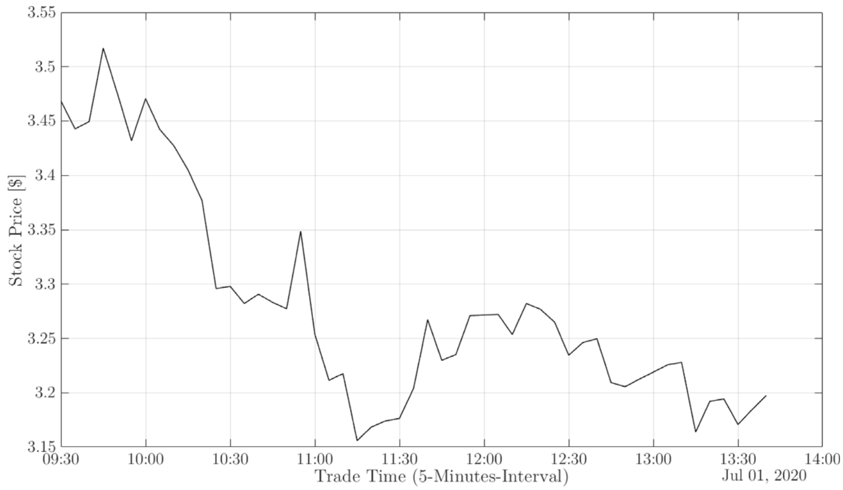

Fig. 6. Hallmark intraday stock price on event day.
The figure shows the stock price development of Hallmark Financial Services Inc. in the first four trading hours of July 1, 2020, where the first two hours correspond to the event period. The depicted price starts with the real stock price and is then calculated using the abnormal returns, thus showing the market-adjusted price development.

In our proposed framework, if a daily SFSE analysis features a structural break in accordance with the specification test, the suggested remedy is to use intraday data and the mcsGARCH model to conduct the event study. Table 6 shows the result when 10 days of 5 min return intervals are used and the event window is set to the first two hours of trading in Hallmark stock on July 1, 2020. As the 10-day calibration period is outside the fever period, there is no issue regarding a structural break in abnormal return volatility. The intraday event study shows that in the first two hours of trading on July 1, 2020, the abnormal return of the event is −9.49%, which is significant at the 5% level. Fig. 6 illustrates the stock price development in the event window based on 5 min-interval abnormal returns of Hallmark stock and clearly shows the strong price decrease, most likely due to the unexpected loss report.

In this particular case, daily and intraday SFSE analyses point to different conclusions. Our SFSE analysis using daily data detects no significant abnormal return and thus no significant negative impact for stockholders, but is likely affected by a structural break and therefore biased. Intraday SFSE analysis reveals a significantly negative abnormal return for investors and thus potential damage when Hallmark published its fourth quarter losses.

6.5. Analysis of securities class action cases

Following on from our detailed study of the Hallmark case in the previous subsection, we now conduct a more systematic analysis of the real-world relevance of structural breaks in SFSE by examining securities class actions. To this end, we draw on the Stanford Law School Securities Class Action Clearinghouse (SCAC) database and search for all cases in which the following criteria applied:

- a security fraud class action according to SEC Rule 10b-5 filed between 2007 and 2017 (1495 cases);
- the defendant was a member of the S&P500 at some point in its lifetime (269 cases);
- our structural break test presented in Section 5 indicates the presence of a break during the one-year period before the class action period end day (55 cases);
- from manual analysis, we can identify the exact date and time of the initial announcement of the event that triggered the class action by searching these companies' Form 8-K disclosures in SEC EDGAR and press coverage in Factiva and Google (42 cases);
- reliable intraday data was available (39 cases).

For each of these 39 cases, we then compare the results of a daily event study with the results of an intraday event study. This allows us to determine whether the use of intraday data may have affected the outcome of each class action, given that the intraday results are at odds with the daily results. Depending on whether the structural break is from a high to a low volatility environment or from a low to a high volatility environment, it is expected that the event studies will over-reject (low-to-high) or under-reject (high-to-low) when tested for significance based on daily data. The full set of estimation results is shown in Appendix F. For the sake of brevity, we only highlight the key findings from the analysis here:

- In 18 of the 39 cases, the daily announcement returns for these companies are below −10%. An eyeball estimate of 'normal' abnormal return volatility is about 1% per day, so each of these cases has about a minimum 10 standard deviation move on the event day. It is not surprising that for all of these extreme returns, the intraday and daily event study results agree and yield a significant negative effect, despite a possible bias in the daily analyses due to the structural break.

Table 7
S&P500 firm class action cases with structural break and diverging event study results.

(1)	(2)	(3)	(4a) Intraday Analysis	(4b)	(5a) Daily Analysis	(5b)	(6)	(7)
Event Time	Company Name	SCAC ID	AR	p-Value	AR	p-Value	Status of Class Action	Break Direction
04/18/2012 12:59:00	Chesapeake Energy Corp.	104885	0.026	0.002	−0.023	0.259	dismissed	high/low
10/28/2016 08:00:38	Exxon Mobil Corp.	105931	−0.015	0.457	−0.023	0.026	ongoing	high/low/high
02/27/2009 16:01:03	General Electric Co.	104257	−0.037	0.147	−0.056	0.004	settled	low/high
10/30/2008 07:37:28	Intl. Game Technology	104341	−0.028	0.481	−0.072	0.003	settled	low/high
02/08/2016 14:36:00	Navient Corp.	105751	0.003	0.823	−0.041	0.015	settled	low/high
05/10/2016 08:16:07	Raymond James & Ass., Inc.	105844	0.017	0.129	0.021	0.045	dismissed	unclear
02/28/2008 07:21:28	Sprint Nextel Corp.	104262	−0.046	0.258	−0.086	0.000	settled	low/high
01/22/2009 06:06:18	SunTrust Banks, Inc.	104259	−0.025	0.450	−0.091	0.034	dismissed	low/high

The table shows announcement effects (abnormal returns, AR, and p-values) for class action lawsuits where S&P500 firms are the defendant. A structural break in daily abnormal return volatility is indicated by our structural break test, and daily and intraday event studies provide contradictory results. All cases are from the Stanford Securities Class Action Clearinghouse (SCAC) database.

- In 8 of the remaining 21 cases (about 38%) with less extreme daily announcement returns, the results of the daily and intraday event studies differ in significance. In seven cases, the intraday result is not significant at a 10% significance level, while it is significant for the daily analysis. In one case, the daily result is not significant, while the intraday result is significant. Table 7 provides details of these cases.

Column (6) of Table 7 shows the status of the class action. We assume that the class action results depend on the empirical evidence provided by an expert's event study, and we further assume that, for the cases analyzed, the event study result would match our OLS results based on daily data. Under these assumptions, the use of intraday analysis could have significantly altered some of the class action results due to the presence of a structural break in daily abnormal return volatility.

- In the one case (Chesapeake, 2012) where the intraday result is significant while the daily result is not, no change in the case outcome would have occurred. The case was actually dismissed, and the significant intraday announcement return is positive. Thus, the alleged misstatements regarding the failure to hedge and the understatement of goodwill impairment do not appear to be supported by the (actual) positive capital market reaction.
- In the seven remaining cases, the significant daily announcement returns and the insignificant intraday announcement returns contradict each other. In five cases this is likely to be due to a (also visually recognizable, see e.g., Fig. 7 for the example of the General Electric case in 2009) change from low to high volatility. Only one (SunTrust Banks) of these five cases was dismissed, while the other four (General Electric, Intl. Game Technology, Navient, and Sprint Nextel) were settled. The average negative daily announcement return in the settled cases is a high 6.40%, which likely gave the plaintiffs some bargaining power. In these cases, the results of the announcement returns, which were actually insignificant according to the intraday analyses, could have potentially changed the settlement results. For Exxon Mobil and Raymond James & Associates, intraday analysis indicates no significant announcement return. The Raymond James case was dismissed, consistent with the intraday result. The Exxon Mobil case is still ongoing.

Finally, referring to the discussion on the length of the event period in Section 6.2 and possible differences in the magnitude of abnormal returns between daily and intraday studies in Section 6.1, we analyze the differences in results that arise from inference based on intraday data. Recall that OLS daily estimates for standard errors were likely biased in the analyzed class action cases due to the incidence of a structural break in the calibration period. To this end, we re-estimate the intraday event studies for all 39 cases using an event period of 6.5 h on the event day, i.e., covering the entire trading day (not reported).

Comparing these results with the daily event study results allows us to identify the changes due to intraday analysis regardless of the length of the event window. We find that both the abnormal return estimates and the t-statistics differ between the daily and full-day-intraday analyses. Accordingly, in seven of the eight cases with inconsistent results (as discussed above), the differences in statistical significance remain. This is partly due to different estimated betas in the calculation of expected event-day returns, but at least in three of the seven cases the differences in results arise from the change in inference methodology when using intraday analysis, so that similar abnormal returns lead to very different standard errors. As an implication, this analysis indicates that intraday results benefit in particular from using unbiased standard errors due to the elimination of biases in daily estimates for standard errors due to structural breaks. The intraday results also appear to be robust against the choice of the event period length, if not chosen to be too short. As stated in Section 6.2, based on our experiences we recommend to use event period length of one to two hours for intraday SFSE analyses.

7. Conclusions

We study inference in single firm/single event studies (SFSE) in the presence of normal, medium, and extreme levels of heteroscedasticity using Monte Carlo and resampling experiments. The analysis covers (i) different methods for inference, (ii) different calibration period lengths, (iii) the use of daily versus intraday data, and (iv) volatility regime shifts in the calibration

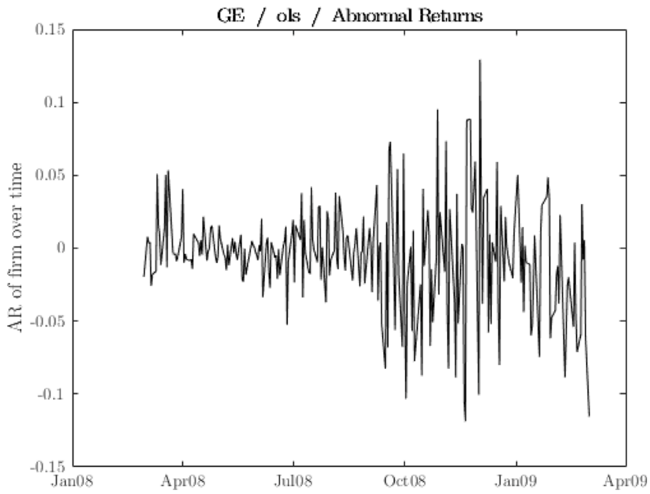

Fig. 7. Daily abnormal return of the General Electric Company SCAC case (ID: 104257, 02/27/2009 16:01:03 ET).
The figure illustrates the daily abnormal stock returns of General Electric Company for a 1-year period before the event date 02/27/2009.

period. The objective of these exercises is to derive a suitable SFSE analysis design that provides appropriate test size and high test power.

We find that even extreme, real-world levels of heteroscedasticity do not lead to problems of inference when using OLS or GARCH for inference in an SFSE setting based on daily data. However, mixed volatility regimes, where calibration and event period occur in different regimes, lead to severe problems of inference on abnormal returns. We devise a statistical test for a structural break in the volatility of daily abnormal returns using the isolation forest machine learning algorithm for outlier detection. We show that this test is well specified in the absence of structural breaks and powerful when detecting structural breaks, even if only approximately 20% of the calibration period's returns are subject to a different volatility regime.

Finally, our analysis shows that intraday data can be reliably used for an SFSE analysis when using an operationalized version of the multiplicative components seasonality GARCH model suggested by Engle and Sokalska (2012). Our resampling experiments show that this estimator leads to well-specified size and a highly powerful significance test when using a 10 to 15 trading day calibration period.

Intraday studies offer a potential solution to the problem of structural breaks in daily abnormal return volatility because the calibration period and event window can be chosen to be much shorter. This is confirmed by our detailed case study of an unexpected corporate loss announcement and a comparison of the results of daily and intraday event studies for a sample of S&P500 companies that were pursued in securities fraud class action lawsuits.

Overall, our analysis implies that reliable SFSE analyses should be conducted by applying the following steps:

1. For data availability reasons, first conduct an event study based on daily data.
2. Test for the existence of a structural break in the volatility of abnormal returns using the derived specification test for short time series.
3. If the test indicates the existance of a structural break in the calibration period, use an event study based on intraday data and apply the mcsGARCH estimator.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The paper is mostly based on Monte Carlo simulations. We share Matlab code among others for the structural break test on https://ralfelsas.de/structural-break-test/. Data for resampling and real-world tests are commercially licensed so cannot be shared.

Appendix A. Patterns in 'normal' vs. 'crisis' period data

We analyze raw (log-)returns and abnormal returns of large U.S. companies for a typical 'normal' period and for a 'crisis' period in order to parametrize our Monte Carlo simulations on daily data. Our one-year normal period starts on August 09, 2006. The

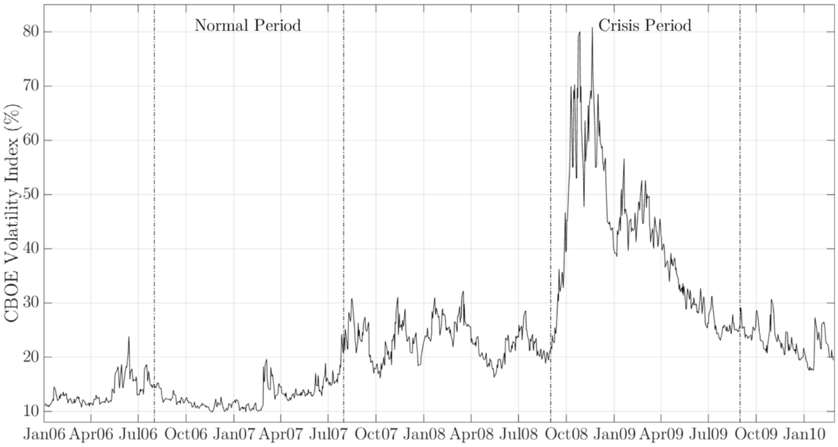

Fig. A.8. CBOE volatility index (VIX).
The figure shows the CBOE Volatility Index (VIX) from January 01, 2006 to March 01, 2010, indicating the 'Normal Period' (August 09, 2006 to August 08, 2007) and the 'Crisis Period' (September 01, 2008 to August 31, 2009) by dashed lines.

Table A.8
Daily log-returns and abnormal returns for the 'normal' and the 'crisis' period.

Period		$Mean$	$\overline{Median}$	$\overline{S.D.}$	$\overline{Skew}$	$\overline{Kurt}$	Min	Max
		Raw Returns						
Normal	Firms	0.0009	0.0009	0.0113	−0.2846	8.1212	−0.1569	0.0800
	S&P500	0.0006	0.0011	0.0071	−1.0163	7.0448	−0.0353	0.0239
Crisis	Firms	−0.0011	−0.0004	0.0397	0.2156	5.8795	−0.9363	0.5068
	S&P500	−0.0009	0.0013	0.0285	−0.0733	5.0398	−0.0947	0.1096
		Abnormal Returns						
Normal		0.0000	−0.0003	0.0090	0.0041	11.1936	−0.1580	0.0762
Crisis		0.0000	−0.0004	0.0260	0.0527	6.4955	−0.8185	0.5217

The table reports descriptive statistics on daily raw returns and abnormal returns of the 29 U.S. Dow Jones Industrial firms and the S&P500 separately for the 'normal' and the 'crisis' period. Abnormal returns are estimated using OLS. Mean, minimum (Min), and maximum (Max) for all firms refer to the global values, i.e., the mean, minimum and maximum of all returns of all firms in each period. The $\overline{Median}$, standard deviation ($\overline{S.D.}$), skewness ($\overline{Skew}$), and kurtosis ($\overline{Kurt}$) are the mean of the 29 firm estimates. Normal period: August 09, 2006 to August 08, 2007; crisis period: September 01, 2008 to August 31, 2009.

one-year crisis period starts on September 01, 2008, so shortly before the bankruptcy of Lehman Brothers on September 15. These periods represent low- vs. high-volatility regimes, as shown in Fig. A.8, depicting the CBOE Volatility Index (VIX).

The return data covers 29 of the 30 U.S. Dow Jones Industrial firms, only excluding General Motors due to their government bailout in 2008. The Standard & Poor's 500 (S&P500) composite index serves as the market index. The 3-month U.S. treasury bill rates are used as the risk-free rate for calculating excess returns. The total return indices for the 29 firms and the S&P500 were collected from the Center for Research in Security Prices (CRSP), the 3-month treasury bill rates are from Thomson Reuters Datastream.

Table A.8 shows descriptive statistics on the log-returns of 29 U.S. Dow Industrial firms and the S&P500. Daily volatility is on average 1.13% (yearly: 17.42%) in the 'normal' period and 3.97% (yearly: 63.00%) in the 'crisis' period. As expected, returns are much more extreme in the crisis period compared with the normal period, with returns between $[-93.63\%, 50.68\%]$ in the crisis period and between $[-15.69\%, 8.00\%]$ in the normal period. Looking at the 1- and 99-percentiles of all returns of all firms confirms that extreme returns appear much more often in the crisis period. Fig. A.9 shows the absolute frequencies of returns appearing in the 1- and 99-percentiles (outliers) in both periods jointly. Outlier returns are most frequent in October 2008, which approximately matches the time of the peak in the volatility index. This time period is characterized by huge market crashes, such as October 6 to 10, the week of the greatest downfall since the Wall Street Crash in 1929, and turnarounds following announcements of state and central bank guarantees and rescue plans (Financial Times 2008, New York Times 2008a,b). Returns have more fat tails than the normal distribution in both periods, are negatively skewed in the normal period, and positively skewed in the crisis period. As the S&P500 captures the market, its returns are fairly similar to the firms' averages, with lower standard deviations in both periods.

Table A.8 additionally reports descriptive statistics on abnormal returns. We estimate abnormal returns using OLS and the market model. As the abnormal returns are the error terms from the OLS regression, mean abnormal returns must be zero. The standard deviations depict a higher volatility in the crisis period, with a daily volatility of 0.90% (yearly volatility: 14.27%) before and 2.60% (yearly: 41.25%) in the crisis. These standard deviations reflect the more extreme abnormal returns in the crisis, with a minimum of −81.85% and a maximum of 52.17%. Abnormal returns are slightly positively skewed and have fat tails in both periods.

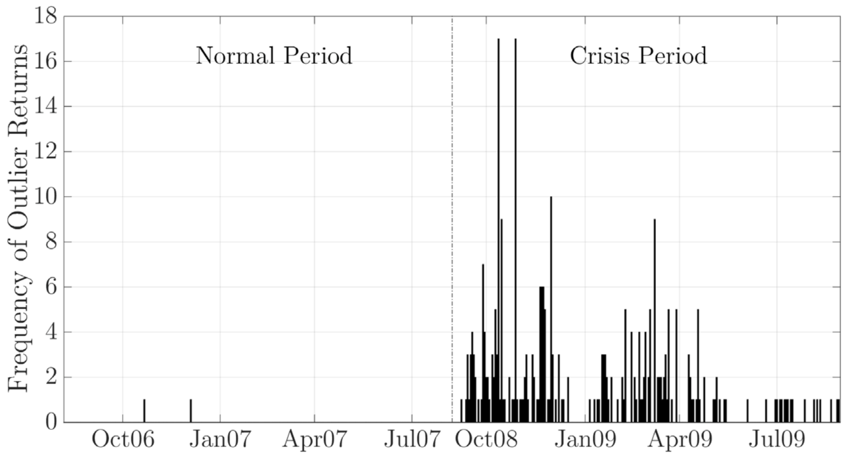

Fig. A.9. Frequency of outlier returns.
The figure shows the frequency of outlier returns of the 29 U.S. Dow Jones Industrial firms, i.e., returns in the 1- and 99-percentiles, for the normal period (August 09, 2006 to August 08, 2007) and the crisis period (September 01, 2008 to August 31, 2009), which are separated by the dashed line.

Table A.9
GARCH parameters.

Period		*Constant*	*GARCH*	*ARCH*	*Degrees of Freedom*
Normal	*mean*	$2.675 \cdot 10^{-5}$	0.470	0.118	8.848
	median	$1.929 \cdot 10^{-5}$	0.458	0.106	4.963
	s.d.	$2.181 \cdot 10^{-5}$	0.369	0.087	13.899
Crisis	*mean*	$5.475 \cdot 10^{-5}$	0.731	0.128	17.120
	median	$1.453 \cdot 10^{-5}$	0.845	0.113	6.755
	s.d.	$7.691 \cdot 10^{-5}$	0.272	0.082	38.198

The table reports the mean, median, and standard deviation of the GARCH(1,1) parameters as estimated from the normal and crisis period index and abnormal returns of the 29 U.S. Dow Jones Industrial companies, assuming t-distributed innovations. Normal period: August 09, 2006 to August 08, 2007; crisis period: September 01, 2008 to August 31, 2009.

Table A.9 reports the mean and median GARCH parameters obtained by applying a GARCH(1,1) estimation assuming t-distributed innovations on S&P500 index returns and the 29 firms' abnormal returns for the 'normal' and the 'crisis' period, respectively. We use the GARCH(1,1) model for analyzing our daily data, since, when using GJR-GARCH, the leverage coefficient was statistically not different from zero for all firms besides one in each period. While the ARCH-parameter remains fairly constant at around 0.1 in both periods, the GARCH-parameter increases in the crisis period by approximately 0.3 (mean from 0.47 to 0.73; median from 0.46 to 0.85). However, both ARCH and GARCH have a fairly high standard deviation, hence vary substantially between firms, with 0.4 (GARCH) and 0.1 (ARCH) in the normal period and 0.3 (GARCH) and 0.1 (ARCH) in the crisis period.

Finally, Fig. A.10 indicates the presence of stochastic volatility and large differences in abnormal return volatility levels between the normal and the crisis period. We estimate conditional volatilities using GARCH(1,1) assuming t-distributed error terms. The upper graph shows conditional volatilities of below 20% for almost the whole period and all shown firms as well as the conditional volatility of the S&P500 returns. Conversely, the lower graph on the crisis period looks quite different. Here, dependent on the firm, conditional volatilities range between approximately 20% and 160%.

Appendix B. Pure normal vs. crisis volatility regimes — size and power test

See Fig. B.11 and Table B.10.

Appendix C. Mixed volatility regimes — size and power test

See Table C.11.

Appendix D. Alternative test for structural breaks

In this appendix, we show simulation results for the test developed by Chuffart et al. (2018), the only alternative test explicitly developed for structural breaks for GARCH models. Because our daily data SFSE setting differs from the setting analyzed by the authors due to the short calibration period, which typically includes only about 252 observations, the size and power of the test in the SFSE setting is unclear.

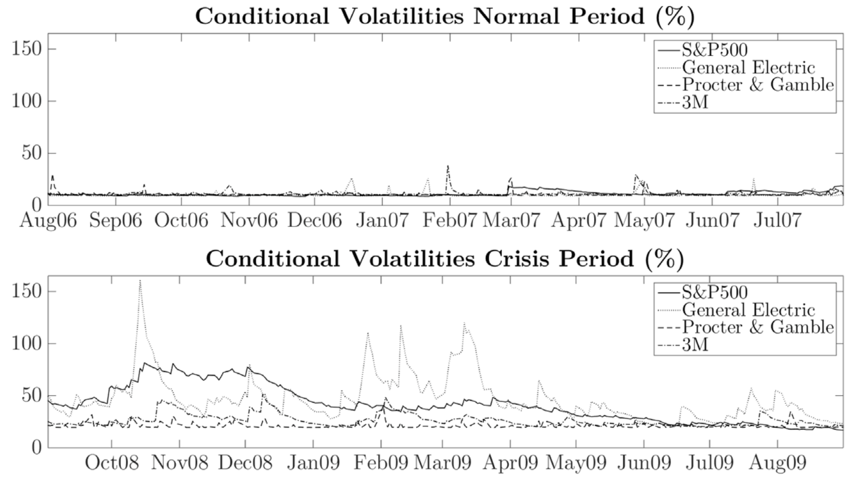

Fig. A.10. Volatility regimes.
The figure shows the conditional volatilities (yearly standard deviations in percent) of the S&P500 returns and the abnormal returns of three example firms, here General Electric (GE), Procter & Gamble, and 3M, for the normal period (August 09, 2006 to August 08, 2007, upper graph) and the crisis period (September 01, 2008 to August 31, 2009, lower graph). Conditional volatilities are estimated using GARCH (1,1), assuming t-distributed error terms.

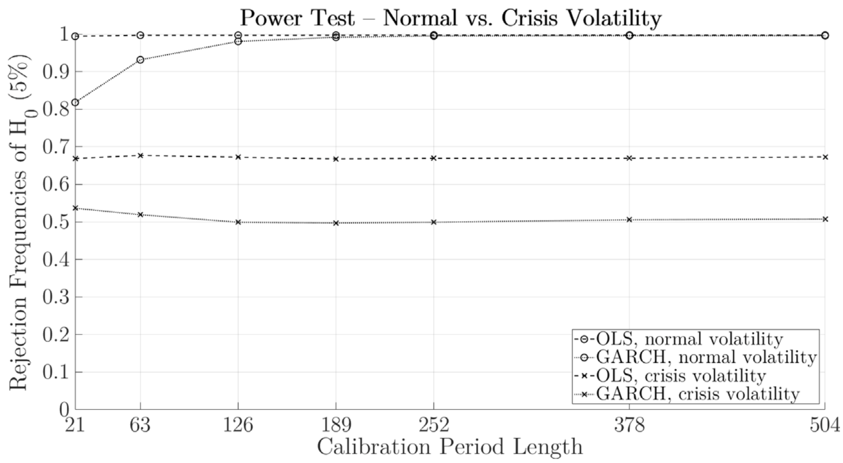

Fig. B.11. Pure normal vs. crisis volatility regimes — power test.
The figure shows the rejection frequencies of the null hypothesis that the event dummy coefficient b_2 equals zero, i.e., $H_0 : b_2 = 0$, in a power test using standard OLS and GARCH for different calibration period lengths for the simulated pure normal and pure crisis volatility regimes. For the power test, 5% abnormal returns are added to the event day return. Calibration period lengths are as follows: 21 days (1 month), 63 days (3 months), 126 days (0.5 year), 189 days (0.75 year), 252 days (1 year), 378 (1.5 years), and 504 (2 years).

The specification test from Chuffart et al. (2018) is a Lagrange Multiplier test that uses Taylor expansion to distinguish between a specific GARCH model and unspecified GARCH-type models as an alternative hypothesis. The considered alternative parameter matrix from the Taylor approximation is reduced by a principal component analysis capturing 90% of overall variability to avoid collinearity problems.[34]

Table D.12 shows results from Monte Carlo simulations in line with those reported in Section 5.2 of the paper. Thus, three different volatility levels, 'crisis', 'medium', and 'normal', are simulated by corresponding GARCH (1,1) processes with t-distributed error terms (see Table 1). When structural breaks occur, the three levels follow the time patterns 'lower-to-higher' or 'higher-to-lower' for all possible combinations of the three regimes. The 'crisis' scenario and the 'normal' scenario have average unconditional return volatility of 40% and 15% p.a. respectively. The 'medium' scenario has an intermediate unconditional volatility of 25% p.a.

All GARCH processes are specified with five degrees of freedom of the t-distribution (see Section 4.2). In addition to the direction of regime change (for example in a high-to-low scenario), the proportion of observations of the respective event day regime also

[34] We use Matlab code for the misspecification test provided by Thomas Chuffart at https://github.com/archuff.

Table B.10
Pure volatility regimes — size and power test for different calibration period lengths.

Rejection rate of H_0 (5%)		Normal period		Crisis period	
		OLS	*GARCH*	*OLS*	*GARCH*
Size Test	*Average abnormal return*	−0.000	−0.000	−0.000	−0.000
	Calibration days				
	21	0.075	0.045	0.071	0.086
	63	0.059	0.047	0.065	0.051
	126	0.056	0.049	0.061	0.047
	189	0.058	0.053	0.059	0.048
	252	0.055	0.052	0.057	0.049
	378	0.055	0.053	0.054	0.048
	504	0.057	0.055	0.054	0.050
Power Test	*Average abnormal return*	0.050	0.050	0.050	0.050
	Calibration days				
	21	0.994	0.818	0.668	0.536
	63	0.997	0.931	0.677	0.519
	126	0.997	0.980	0.672	0.499
	189	0.997	0.991	0.667	0.497
	252	0.997	0.995	0.669	0.499
	378	0.997	0.996	0.669	0.505
	504	0.997	0.996	0.673	0.507

The table shows the Monte Carlo simulation results of the size and power tests for the two more extreme pure volatility regimes 'normal' and 'crisis'. It shows mean rejection frequencies of the null hypothesis that the event dummy coefficient b_2 equals zero, i.e., $H_0 : b_2 = 0$, using OLS and GARCH for different calibration period lengths and one event day at a 5% significance level. In particular, we measure rejection frequencies using calibration periods of length 21 days (1 month), 63 days (3 months), 126 days (0.5 year), 189 days (0.75 year), 252 days (1 year), 378 (1.5 years), and 504 (2 years). For the power test, 5% abnormal returns are added to each event day return.

Table C.11
Mixed volatility regimes — size test for different mixed volatility calibration periods.

Rejection rate of H_0 (5%)	Normal to Crisis		Normal to Medium		Medium to Crisis	
	OLS	*GARCH*	*OLS*	*GARCH*	*OLS*	*GARCH*
Average abnormal return	0.000	−0.000	−0.000	−0.000	0.000	−0.000
Share of event day regime						
1/12	0.290	0.249	0.165	0.155	0.148	0.133
3/12	0.194	0.058	0.131	0.098	0.119	0.089
6/12	0.117	0.005	0.095	0.053	0.089	0.055
9/12	0.078	0.006	0.070	0.045	0.070	0.046
11/12	0.062	0.034	0.060	0.052	0.060	0.048
	Crisis to Normal		Crisis to Medium		Medium to Normal	
	OLS	*GARCH*	*OLS*	*GARCH*	*OLS*	*GARCH*
Average abnormal return	−0.000	−0.000	−0.000	−0.000	−0.000	−0.000
Share of event day regime						
1/12	0.002	0.002	0.014	0.014	0.010	0.010
3/12	0.003	0.002	0.018	0.017	0.013	0.012
6/12	0.005	0.005	0.025	0.026	0.020	0.020
9/12	0.014	0.017	0.035	0.036	0.033	0.034
11/12	0.032	0.035	0.047	0.047	0.046	0.046

The table shows the Monte Carlo simulation results of size tests for different mixed calibration period combinations with shares of the event day regime between 1 and 11 out of 12 months. It shows the mean rejection frequencies of the null hypothesis that the event dummy coefficient b_2 equals zero, i.e., $H_0 : b_2 = 0$, using OLS and GARCH at a 5% significance level.

varies between 10%–40%. Additionally, results are shown for scenarios without changes in volatility regimes (i.e., 100% in the same regime). The number of simulations per analyzed scenario is 500; the simulated return time series each comprise 253 time series observations.

As can be seen from Panel A in Table D.12, the size of the test is well specified, since all rejection rates when there is no structural break in the abnormal returns are approximately equal to 5% (tested at a 5% significance level). However, Panel B of the table shows results for scenarios where there actually is a structural break. All rejection rates are again close to 5%. Thus, the test is not able to detect a structural break if there is one, regardless of the intensity of the volatility change or its direction (higher-to-lower or lower-to-higher). This seems to be due to the short time series used for calibration in the SFSE setting, as Chuffart et al. (2018) report high test power when applying the test to long time series with several thousand observations.

Table D.12
Simulation results for the Chuffart et al. (2018) GARCH structural break test.

Panel A: Size test			
Share of event day regime	Normal	Medium	Crisis
100%	0.047	0.061	0.064
Panel B: Power test			
Share of event day regime	Normal to Crisis	Normal to Medium	Medium to Crisis
10%	0.051	0.049	0.054
20%	0.038	0.054	0.062
30%	0.024	0.065	0.058
40%	0.023	0.066	0.058
	Crisis to Normal	Crisis to Medium	Medium to Normal
10%	0.048	0.068	0.061
20%	0.032	0.058	0.058
30%	0.044	0.048	0.058
40%	0.029	0.056	0.065

The table reports the detection frequency of structural breaks using the Chuffart et al. (2018) GARCH structural break test for different pure and mixed volatility calibration period regimes, based on 500 simulated abnormal return paths with 253 observations for each setting. Volatility regimes are defined in Table 1. Panel A shows the size of the structural break test since the simulated returns do not have a structural break in the pure 'normal', 'medium', and 'crisis' scenarios. Panel B shows the power of the structural break test, when abnormal returns first have lower and then higher volatility and vice versa.

Table E.13
Model parameters for Monte Carlo simulation of intraday data.

Period		*GARCH*	*ARCH*	*Degrees of Freedom*	*Daily Unconditional Variance*
Normal	3M	0.269	0.392	3.085	0.008
	S&P1500	0.714	0.138	2.166	0.021
Crisis	3M	0.761	0.171	4.603	0.019
	S&P1500	0.793	0.130	4.254	0.251

The table shows parameter estimates for 3M Corp. and the S&P 1500 index according to a GARCH(1,1) estimation with t-distributed errors. These parameters are used as inputs to the Monte Carlo simulations of intraday return data. The estimation is based on 5-minute intraday returns from January 2 to January 16, 2013 ('normal' period), and October 01 to October 15, 2008 ('crisis' period).

Table E.14
Monte Carlo simulation using intraday data — size and power test.

Rejection rate of H_0(5%)	Normal period				Crisis period			
	OLS	*White*	*GARCH*	*mcs GARCH*	*OLS*	*White*	*GARCH*	*mcs GARCH*
	Size Test							
Calibration days								
5	0.055	0.061	0.043	0.098	0.053	0.063	0.049	0.054
10	0.050	0.063	0.041	0.047	0.055	0.067	0.041	0.052
15	0.052	0.061	0.039	0.042	0.052	0.065	0.041	0.047
	Power Test							
Calibration days								
5	1.000	1.000	1.000	0.966	0.995	0.987	0.918	0.982
10	1.000	0.999	1.000	0.972	0.996	0.988	0.950	0.962
15	1.000	1.000	1.000	0.951	0.996	0.988	0.959	0.963

The table shows rejection frequencies of the null hypothesis that the event dummy coefficient b_2 equals zero, i.e., $H_0 : b_2 = 0$, in size and power tests for different estimators and calibration period lengths based on simulated intraday data. Abnormal security returns and market returns are generated by a GARCH(1,1) model with t-distributed errors. The model is calibrated using 5-minute-interval data for 3M Corp and the S&P 1500 index from January 2 to January 16, 2013 ('normal' period) and from October 01 to October 15, 2008 ('crisis' period). Calibration days denote the number of trading days used as the length of the calibration period in the event study regression. Events are assumed to take place in the first 24 5-minute intervals of the next trading day (corresponding to 2 h of trading). For the power test, a 5% return is added linearly to mean-zero abnormal returns during the event window. The number of simulations is 30,000 for each specification of calibration days, estimator, and volatility regime.

Appendix E. Monte Carlo evidence on SFSE properties

The Monte Carlo study is again set up by simulating stock returns with a GARCH model. The model is calibrated on intraday data for large U.S. firms. To calibrate the two volatility regimes 'normal' and 'crisis', we rely on the time periods from January 02 to January 16, 2013 and from October 01 to October 15, 2008, respectively (both periods comprise 10 trading days).[35] The

[35] Due to data availability, for a normal volatility environment we choose the year 2013 instead of the year 2006, as for daily data in the preceding analyses.

Table F.15
Analysis of SCAC cases by S&P500 companies.

Event time	Company name	SCAC ID	Intraday Analysis		Daily Analysis	
			AR	p-value	AR	p-value
10/24/2007 16:03:59	Align Technology, Inc.	104358	−0.352	0.000	−0.407	0.000
11/12/2008 07:32:47	American Express Co.	104236	−0.031	0.374	−0.029	0.192
05/02/2017 16:28:50	Anadarko Petroleum Corp.	106159	−0.076	0.017	−0.075	0.000
08/03/2010 18:28:00	Apollo Group, Inc.	104529	0.015	0.316	−0.003	0.904
01/16/2009 07:06:18	Bank of America Corp.	104217	−0.115	0.015	−0.171	0.000
01/20/2010 07:13:40	Bank of America Corp.	104437	0.020	0.208	0.042	0.412
03/15/2010 09:30:00	Boston Scientific Corp.	104469	−0.174	0.001	−0.136	0.000
01/27/2009 21:03:00	Chesapeake Energy Corp.	104248	0.007	0.802	−0.026	0.501
04/18/2012 12:59:00	Chesapeake Energy Corp.	104885	0.026	0.002	−0.023	0.259
03/27/2013 09:30:00	Cliffs Natural Resources Inc.	105218	−0.150	0.003	−0.143	0.000
05/05/2016 16:22:04	Endo International Plc.	105806	−0.475	0.000	−0.501	0.000
10/28/2016 08:00:38	Exxon Mobil Corp.	105931	−0.015	0.457	−0.023	0.026
02/28/2012 16:29:22	First Solar, Inc.	104873	−0.090	0.033	−0.108	0.001
05/02/2017 16:22:57	Frontier Communications Corp.	106348	−0.087	0.012	−0.181	0.000
02/27/2009 16:01:03	General Electric Co.	104257	−0.037	0.147	−0.056	0.004
10/20/2017 07:55:44	General Electric Inc.	106392	−0.023	0.226	0.007	0.461
10/11/2016 08:41:01	Illumina, Inc.	105994	−0.258	0.002	−0.266	0.000
10/20/2014 06:14:56	IBM Corp.	105359	−0.073	0.003	−0.082	0.000
10/30/2008 07:37:28	International Game Technology	104341	−0.028	0.481	−0.072	0.003
02/28/2008 09:00:00	Limited Brands, Inc.	104392	−0.074	0.000	−0.104	0.000
09/29/2016 08:07:07	Linear Technology Corp.	105911	−0.001	0.710	0.007	0.550
10/06/2011 16:24:44	Metlife, Inc.	104837	−0.023	0.079	−0.044	0.000
07/18/2013 16:07:54	Microsoft Corp.	105087	−0.082	0.001	−0.122	0.000
02/08/2016 14:36:00	Navient Corp.	105751	0.003	0.823	−0.041	0.015
05/12/2016 06:10:16	Perrigo Co. plc	105830	−0.023	0.097	−0.039	0.017
01/26/2009 07:38:58	Pfizer Inc.	104486	−0.097	0.008	−0.115	0.000
10/29/2007 16:20:37	Pitney Bowes, Inc.	104389	−0.141	0.056	−0.156	0.000
05/10/2016 08:16:07	Raymond James &Associates, Inc.	105844	0.017	0.129	0.021	0.045
04/15/2009 00:16:00	Raymond James Financial, Inc.	104321	−0.223	0.004	−0.168	0.000
01/20/2009 10:14:51	Regions Financial Corp.	104581	−0.070	0.015	−0.195	0.000
05/23/2014 13:42:16	Safeway Inc.	105233	0.000	0.962	−0.006	0.646
03/26/2015 09:30:00	SanDisk Corp.	105600	−0.175	0.002	−0.201	0.000
08/25/2016 07:43:11	Signet Jewelers Ltd.	105886	−0.142	0.000	−0.132	0.000
02/28/2008 07:21:28	Sprint Nextel Corp.	104262	−0.046	0.258	−0.086	0.000
01/22/2009 06:06:18	SunTrust Banks, Inc.	104259	−0.025	0.450	−0.091	0.034
10/03/2016 10:26:33	Tenet Healthcare Corp.	105915	−0.009	0.485	−0.032	0.222
01/29/2009 08:15:47	Textron Inc.	104355	−0.297	0.000	−0.335	0.000
02/05/2009 17:22:13	The Hartford Financial Services Group, Inc.	104467	−0.369	0.001	−0.216	0.003
01/19/2016 18:38:36	The Williams Companies, Inc.	105739	−0.003	0.960	0.005	0.862

The table shows announcement effects for class action suits where S&P500 firms are the defendant, and a structural break in daily abnormal return volatility is indicated by our structural break test (Section 5). All cases are from the Stanford Securities Class Action Clearinghouse (SCAC) database. Intraday SFSE uses the mcsGARCH model described in Section 6.3, with a 10-day calibration period, an event window of 24 5-minute intervals and mean-measurement of intraday volatility patterns. Daily SFSE results are based on OLS estimation, with a 252 trading day calibration period. Confounding events (Form 8-K) before the event day are excluded from the estimation. Note that in the cases where the time in the table matches the start of the trading day (09:30:00), press information indicated that information was released before trading hours, without mentioning the exact publishing time.

crisis period reflects the height of the subprime crisis, during which, for example, the U.S. Troubled Asset Relief Program TARP was initiated (October 3) and the October 6 market crash occurred.

As before, we use a GARCH(1,1)-model with t-distributed error terms to simulate return data. We further choose 3M Corp. as the representative firm for model parameters of the simulation. Please note that the choice of 3M does not affect our results. Due to Bloomberg data availability, we use the S&P1500 as the proxy for the market portfolio. GARCH-model parameters for 3M and the index are reported in Table E.13. The table shows that the two scenarios are very different. While a daily (unconditional) return volatility of 0.8% is a typical value for large firms in normal market environments, this volatility more than doubles to a level of 1.9% during the crisis period.

We define the event window size in the Monte Carlo simulation to be equal to the equivalent of two trading hours. Anecdotal evidence of intraday announcements suggests that such a time period is sufficient to achieve full information processing for liquid stocks.

Also, we define a trading day to consist of 103 5-minute min intervals, constituting 8.5 trading hours plus an additional 5-minute interval for the closing auction. This implies that the event window of 2 trading hours consists of 24 5-minute-return observations. For the power tests, we equally distribute the 5% added abnormal return across the 24 event window observations. Note that increasing the time interval for a given length of daily trading reduces the number of return observations, thereby also reducing the number of observations used for the calibration period. None of our results depend qualitatively on these parameter choices, except for the choice of calibration period length.

We test power and size for different estimators, comprising OLS, GARCH, and White estimation. Since little is known about the suitable design of intraday studies in an SFSE context, we also compare the statistical characteristics of all estimators for different lengths of the calibration period, considering 5, 10, and 15 days.

Table E.14 shows average rejection rates from 30,000 Monte Carlo simulations per specification. Columns 2–4 show rejection rates for OLS, White, and GARCH estimation for a calibration window length of 5, 10, and 15 trading days during the 'normal' volatility regime. Both OLS and GARCH estimation show reasonable test sizes at a 5% significance level. While OLS has a slight tendency to over-reject (with rejection rates ranging between 5.1% and 5.8%), GARCH has a tendency to under-reject (rejection rates are between 3.9% and 4.3%). White estimation over-rejects, similar to the daily return result. There is no difference regarding the power of the tests as all estimators almost always detect a 5% return. During the 'crisis' volatility regime, test size results are similar (see columns 6–8 in Table E.14). OLS and GARCH estimation have rejection rates reasonably close to the 5% significance level, while White estimation still over-rejects, with a rejection rate of about 6%. The furthermore depicted multiplicative component seasonality GARCH estimator (mcsGARCH, columns 5 and 9 in Table E.14) is discussed in Section 6.3.

A closer examination of the properties of the White estimator shows that the sparse vector-problem still affects the validity of the estimator. For example, reducing the event window length increases the sparsity of the event dummy vector and leads to stronger over-rejection of the White estimator.[36] The power tests show that all tested estimators have the power to detect an event-driven abnormal return of 5%, if there is one, in almost all cases.

Comparing the impact of the length of the calibration period shown in Table E.14 indicates that a 5-day calibration window (which comprises about 500 return observations in the calibration period) is already sufficient to achieve appropriate type I error rates with high power. However, as seen in Section 6.3, the simulated data differs from real-world intraday data in one crucial aspect, meaning that a conclusion on the optimal design of an intraday SFSE analysis would be premature.

Appendix F. Analysis of SCAC cases

See Table F.15.

References

Aktas, N., de Bodt, E., Cousin, J.-G., 2007. Event studies with a contaminated estimation period. J. Corp. Finance 13 (1), 129–145. http://dx.doi.org/10.1016/j.jcorpfin.2006.09.001.

Baker, A.C., 2016. Single-firm event studies, securities fraud, and financial crisis: problems of inference. Stanf. Law Rev. 68, 1207–1266.

Boehmer, E., Musumeci, J., Poulsen, A., 1991. Event study methodology under conditions of event induced variance. J. Financ. Econ. 30, 253–272. http://dx.doi.org/10.1016/0304-405X(91)90032-F.

Bollerslev, T., 1986. Generalized autoregressive conditional heteroskedasticity. J. Econometrics 31 (3), 307–327. http://dx.doi.org/10.1016/0304-4076(86)90063-1.

Brav, A., Heaton, J., 2015. Event studies in securities litigation: low power, confounding effects, and bias. Wash. Univ. Law Rev. 93, 583–614.

Brown, S.J., Warner, J.B., 1985. Using daily stock returns: the case of event studies. J. Financ. Econ. 14 (1), 3–31. http://dx.doi.org/10.1016/0304-405X(85)90042-X.

Brunnermeier, M.K., 2009. Deciphering the liquidity and credit crunch 2007–2008. J. Econ. Perspect. 23 (1), 77–100. http://dx.doi.org/10.1257/jep.23.1.77.

Bundesbank, D., 2016. Bedeutung und Wirkung des Hochfrequenzhandels am deutschen Kapitalmarkt. URL: http://www.bundesbank.de/redaktion/de/downloads/veroeffentlichungen/monatsberichtsaufsaetze/2016/2016_10_hochfrequenzhandel.pdf.

Busse, J.A., Green, T.C., 2002. Market efficiency in real time. J. Financ. Econ. 65 (3), 415–437. http://dx.doi.org/10.1016/S0304-405X(02)00148-4.

Campbell, J., Campbell, J., Lo, A., Lo, P., Lo, A., MacKinlay, A., 1997. The econometrics of financial markets. In: Book collections on Project MUSE, Princeton University Press, URL: https://books.google.de/books?id=lkeKhnqUHx8C.

Chuffart, T., Flachaire, E., Péguin-Feissolle, A., 2018. Testing for misspecification in the short-run component of GARCH-type models. Stud. Nonlinear Dyn. Econom. 22, http://dx.doi.org/10.1515/snde-2017-0069.

Cornerstone Research, 2020. Securities class action filings – 2019 year in review. Cornerstone Research. URL: https://www.cornerstone.com/Publications/Reports/Securities-Class-Action-Filings-2019-Year-in-Review. last access date: 27 Oct 2020.

Corrado, C., 1989. A nonparametric test for abnormal security-price performance in event studies. J. Financ. Econ. 23, 385–395. http://dx.doi.org/10.1016/0304-405X(89)90064-0.

De Jong, F., Kemna, A., Kloek, T., 1992. A contribution to event study methodology with an application to the dutch stock market. J. Bank. Financ. 16 (1), 11–36. http://dx.doi.org/10.1016/0378-4266(92)90076-C.

Efron, B., Tibshirani, R.J., 1993. An Introduction to the Bootstrap, first ed. CRC Press, Boca Raton.

Engle, R.F., 1982. Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation. Econometrica 50 (4), 987–1007. http://dx.doi.org/10.2307/1912773.

Engle, R.F., Sokalska, M.E., 2012. Forecasting intraday volatility in the U.S. equity market. Multiplicative component GARCH. J. Financ. Econom. 10 (1), 54–83. http://dx.doi.org/10.1093/jjfinec/nbr005.

Fama, E.F., Fisher, L., Jensen, M.C., Roll, R., 1969. The adjustment of stock prices to new information. Internat. Econom. Rev. 10 (1), 1–21. http://dx.doi.org/10.2307/2525569.

Financial Times, 2008. Market crash shakes world. Financial Times. URL: https://www.ft.com/content/a0eac1e2-96f0-11dd-8cc4-000077b07658. last access date: 20 Feb 2018.

Fisch, J.E., Gelbach, J.B., 2021. Power and statistical significance in securities fraud litigation. Harv. Bus. Law Rev. 11, 55.

Fisch, J.E., Gelbach, J.B., Klick, J., 2018. The logic and limits of event studies in securities fraud litigation. Texas Law Rev. 96, 553–621.

[36] The fraction of non-zero elements in the event dummy decreases by either shortening the event window for a given minute-interval of intraday data aggregation, or by keeping the time length of the event window constant but increasing the time interval, e.g., going from 5 min to 15 min intervals. The over-rejection is even worse when using the Newey–West correction (untabulated).

Giaccotto, C., Ali, M.M., 1982. Optimum distribution-free tests and further evidence of heteroscedasticity in the market model. J. Finance 37 (5), 1247–1257. http://dx.doi.org/10.2307/2327848.

Glosten, L.R., Jagannathan, R., Runkle, D.E., 1993. On the relation between the expected value and the volatility of the nominal excess return on stocks. J. Finance 48 (5), 1779–1801. http://dx.doi.org/10.2307/2329067.

Greene, W.H., 2008. Econometric Analysis, sixth ed. Pearson Education Inc. New Jersey.

Huber, P., 1981. Robust Statistics. In: Wiley Series in Probability and Statistics, Wiley.

Karpoff, J.M., Lee, D.S., Martin, G.S., 2008. The cost to firms of cooking the books. J. Financ. Quant. Anal. 43 (3), 581–611. http://dx.doi.org/10.1017/S0022109000004221.

Kothari, S.P., Warner, J.B., 2007. Econometrics of event studies. In: Handbook of Empirical Corporate Finance. Elsevier, pp. 3–36. http://dx.doi.org/10.1016/B978-0-444-53265-7.50015-9.

Liu, F.T., Ting, K.M., Zhou, Z.-H., 2012. Isolation-based anomaly detection. ACM Trans. Knowl. Disc. Data (TKDD) 6 (1), 1–39. http://dx.doi.org/10.1145/2133360.2133363.

Ljung, G.M., Box, G.E., 1978. On a measure of lack of fit in time series models. Biometrika 65 (2), 297–303. http://dx.doi.org/10.1093/biomet/65.2.297.

MacKinlay, A.C., 1997. Event studies in economics and finance. J. Econ. Lit. 35 (1), 13–39.

Mammen, E., 1993. Bootstrap and wild bootstrap for high dimensional linear models. Ann. Statist. 21 (1), 255–285. http://dx.doi.org/10.1214/aos/1176349025.

Marks, J.M., Musumeci, J., 2017. Misspecification in event studies. J. Corp. Finance 45, 333–341. http://dx.doi.org/10.1016/j.jcorpfin.2017.05.003.

Mitchell, M.L., Netter, J.M., 1994. The role of financial economics in securities fraud cases: applications at the Securities and Exchange Commission. Bus. Lawyer 49 (2), 545–590, URL: http://www.jstor.org/stable/40687469.

Mucklow, B., 1994. Market microstructure: an examination of the effects on intraday event studies. Contemp. Account. Res. 10 (2), 355–382. http://dx.doi.org/10.1111/j.1911-3846.1994.tb00397.x.

New York Times, 2008a. Even as Dow Soars 11%, Skeptics Lurk. URL: http://www.nytimes.com/2008/10/29/business/29markets.html. last access date: 20 Feb 2018.

New York Times, 2008b. Stocks soar 11 percent on aid to banks. URL: http://www.nytimes.com/2008/10/14/business/14markets.html. last access date: 20 Feb 2018.

Newey, W.K., West, K., 1987. A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. Econometrica 55 (3), 277–293. http://dx.doi.org/10.2307/1913610.

Ramelli, S., Wagner, A.F., 2020. Feverish stock price reactions to COVID-19. Rev. Corp. Finance Stud. 9, 622–655. http://dx.doi.org/10.1093/rcfs/cfaa012.

Rogers, J.L., Skinner, D.J., Zechman, S.L., 2017. Run EDGAR run: SEC dissemination in a High-Frequency world. J. Account. Res. 55 (2), 459–505. http://dx.doi.org/10.1111/1475-679X.12167.

Salinger, M., 1992. Standard errors in event studies. J. Financ. Quant. Anal. 27 (1), 39–53. http://dx.doi.org/10.2307/2331297.

Savickas, R., 2003. Event-induced volatility and tests for abnormal performance. J. Financial Res. 26 (2), 165–178. http://dx.doi.org/10.1111/1475-6803.00052.

Sharpe, W.F., 1963. A simplified model for portfolio analysis. Manage. Sci. 9 (2), 277–293. http://dx.doi.org/10.1287/mnsc.9.2.277.

Smith, D.R., 2008. Testing for structural breaks in GARCH models. Appl. Financial Econ. 18, 845–862. http://dx.doi.org/10.1080/09603100701262800.

Strang, G., 2009. Introduction to Linear Algebra, fourth ed. Wellesley-Cambridge Press, URL: https://books.google.de/books?id=M19gPgAACAAJ.

Torchio, F., 2009. Proper event study analysis in securities litigation. J. Corp. Law 35, 159–168.

White, H., 1980. A Heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. Econometrica 48 (4), 817–838. http://dx.doi.org/10.2307/1912934.